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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

EUPHORBIA TIRUCALLI RESIN FROM SOUTH AFRICA

IN an article on "Some Little-known Resins," published in this BULLETIN, 1915, **13**, 361, an account was given of an investigation of samples of the coagulated latex of *Euphorbia tirucalli* from Natal, carried out at the Institute in 1911 and 1913. The latex was found to contain 14·3 to 15·7 per cent. of caoutchouc and 75·8–82·1 per cent. of resin, expressed on the dry material. From the tests then made it was considered that the resin was not suitable for varnishes prepared by the usual methods. The question was re-opened recently when, owing to the rubber shortage, the possibility of producing caoutchouc from *Euphorbia tirucalli* in South Africa was again investigated. The resin, which forms the major part of the coagulum, would be a by-product in the separation of the rubber and a part of the problem was to find an industrial use for the resin in the hope of offsetting the cost of extracting the rubber, which cost it was anticipated would be relatively high. An extensive investigation of the material has therefore been conducted with a supply sent to the Imperial Institute.[1]

[1] Since the investigations recorded in this report were concluded, it is learned that, as a result of work carried out in South Africa, the Authorities there consider that the cost of production is too high for this source of rubber to be utilized, even under the present conditions of rubber shortage.

In November 1942 a sample of the resin was sent to the Imperial Institute by the Trade Commissioner for the Union of South Africa in London, with a view to determining its properties and its likely use in industry. A report on the preliminary work was submitted to the South African authorities in June 1943, and a further report on more detailed tests was furnished in September 1943. These reports are printed below.

Prior to reporting to South Africa, the results of the preliminary work were communicated to the Paint Research Station, Teddington, together with a quantity of the resin for laboratory trials which they kindly undertook to carry out. Their results were in agreement with those obtained at the Imperial Institute showing that the crystallisation of the resin from solution was a serious objection to the use of the resin.

The further work, incorporated in the second report, carried out at the Imperial Institute, overcame the difficulty mentioned, and the results were submitted to the Paint Research Station, which conducted further trials on the lines of the formulae suggested by the Institute and presented a second report, again in agreement with the results obtained at the Institute.

For the purpose of publication, Dr. L. A. Jordan, the Director of the Paint Research Station, has furnished a statement combining his two reports, and this is printed as an appendix.

The results of these laboratory investigations indicate that *Euphorbia tirucalli* resin could be utilised for the preparation of short oil stoving varnishes which would have a commercial outlet in the manufacture of waterproof fabrics, leather finishes, and finishes for the interior of shells; for this purpose the formulae given in the second Institute report should serve as a basis.

First Report by the Imperial Institute

The sample of resin forwarded by the Trade Commissioner for the Union of South Africa in November 1942 was stated to have been prepared in Natal by extraction with denatured alcohol of the coagulum obtained from the latex of *Euphorbia tirucalli*. It weighed 20 lb., and consisted of lumps, fragments and powder, varying in colour from light to dark yellowish-brown. The material was brittle.

The resin was submitted to a chemical examination and to varnish trials with the following results. The figures for a sample of the resin examined at the Institute in 1928 are given for comparison.

		Present Sample.	Previous Sample.
Loss at 100° C. in vacuo	*per cent.*	5·8	—
Ash	„	0·6	0·05
Acid value		6·3	1·1
Saponification value . . .		45·1	41·2
Melting point ° C. (complete fusion)		51	48-50

Solubility

Solvent.	In the cold.	On heating.	On cooling.	After standing for 24 hours.
Acetone	Partly soluble.	Nearly completely soluble. Solution very turbid.	Some flocculent precipitate. Turbidity reduced to opalescence.	No change.
Alcohol (95 per cent.)	Partly soluble. Flocculent sediment.	Almost completely soluble. Turbid solution.	Some flocculent precipitate. Turbidity slightly reduced.	Turbidity reduced to opalescence.
Benzene	Almost completely soluble. Somewhat turbid solution.	Completely soluble. Opalescent solution.	Very slight brown sediment. Solution turbid.	No change.
Chloroform	Almost completely soluble. Solution less turbid than benzene solution.	Completely soluble. Almost clear solution.	No change.	No change.
Ether	Almost completely soluble. Somewhat turbid solution.	Solubility increased very little. Opalescent solution.	Slight brown sediment. Slight increase in turbidity.	No change.
Petrol Ether (b.p. 60°–80° C.)	Practically insoluble.	Solubility increased but a considerable portion still insoluble. Turbid solution.	No change.	No change.
Turpentine	Almost completely soluble. Somewhat turbid solution.	Completely soluble. Opalescent solution.	No change.	No change.

Varnish Trials

1. *With Alcohol.*—A varnish was prepared by dissolving 1 part of resin in 1 part of 95 per cent. alcohol. When applied to sized wood the surface of the varnish was dry to the touch in 1 hour and hard dry in 17 hours, with a fairly glossy finish. On keeping the surface dulled off slightly, but after a week the finish was still satisfactory. The finish gradually deteriorated until after 14 days the surface was considerably duller. The film was fairly brittle.

2. *With Turpentine.*—A varnish was prepared by dissolving 1 part of resin in 1 part of turpentine. On sized wood the surface was dry to the touch in 24 hours and hard dry in 4 days, the finish being moderately glossy. The finish had not deteriorated in any way after 7 days. After 14 days, however, the surface had commenced to dull. The film was not as brittle as that produced by the spirit varnish.

3. *With Linseed Oil.*—4 parts of resin were run at approximately 250° C. for 10 minutes and allowed to cool to 200° C. To the run resin 6 parts of raw linseed oil at 200° C. were added, followed by 3 parts of thinner (consisting of 4 parts of white spirit and 1 part of naphtha). On cooling the varnish remained clear and was then applied to sized wood. The film rapidly dulled, apparently owing to the deposition of crystals. The varnish was very slow in drying, and when dry entirely lacked gloss and was poor in body. On standing the varnish slowly deposited crystals.

Conclusions

In many respects the present sample of *Euphorbia tirucalli* resin resembles the previous one examined. It may, however, be pointed out that the previous sample had been extracted from the coagulum by means of acetone whereas in the present case denatured alcohol had been used. The analytical figures for both samples are very similar, but there is a difference in the solubilities, especially in petrol ether, in which solvent the present sample was practically insoluble.

Alcohol varnishes made from these samples also differed, the earlier one giving a rather sticky film. The earlier turpentine varnish took longer to dry (14 days against 4 days for the present one), and both dulled off on standing for several weeks. Varnishes made with linseed oil were unsatisfactory in both cases.

On the whole, the present sample does not appear to be any more promising than the previous one as a varnish-making material. The resin gives a film which easily weathers and becomes dull, lacking in durability. Its most likely use would be as a constituent of spirit varnishes, but the difficulty of obtaining adequate supplies of ethyl alcohol might curtail, or even prevent, its use for this purpose at the present time.

Second Report by the Imperial Institute

This report records the further investigation of the sample of resin dealt with in the First Report.

Restricting Properties of the Resin

In the preliminary trials it was found that apart from its low melting point (51° C.) and its brittleness this resin had the disadvantage of separating from the oil vehicle in the form of a crystalline mass. Unless this defect could be overcome the resin would be of no value as an oil varnish ingredient.

The following data were obtained from preliminary experiments :

(*a*) The resin was soluble in linseed oil on heating, but was mainly deposited on cooling, and running of the resin up to a temperature of 250° C. had only little effect on its solubility.

(*b*) On the other hand, careful running at 300° C. or slightly above appeared to increase the solubility of the resin in oil.

(*c*) Owing to its poor solubility in white spirit, thinners consisting of a mixture of white spirit and naphtha were unsuitable for use with this resin.

(*d*) On the other hand, turpentine was a good solvent, and a mixture of this solvent and white spirit was found to be fairly good for thinning.

(*e*) Gold size, i.e. a short oil varnish containing a minimum amount of oil, a maximum amount of driers and a high proportion of thinners, increased the stability of the resin in linseed oil.

Effect of Crystallisation on the Varnish Film

A varnish prepared from the resin did not necessarily deposit crystalline material immediately on cooling, and it could stand for several days before a deposit formed. It was found, however, that an unstable varnish showed itself in the freshly-painted out film by rapid loss of gloss due to the deposition of small crystals in the film. If this film (on tin) were allowed to dry and then submitted to accelerated drying (stoving at 120° C., a temperature well above the melting point of the resin) the crystals melted and a clear glossy film was obtained which remained clear on cooling and after standing.

In connection with this crystallisation effect it was found that the resin to a large extent could be dissolved in hot petroleum ether (b.p. 60-80° C.) and that on cooling in the refrigerator to about 5° C. a large quantity of crystalline material was deposited. This was filtered off and dried. It was found that 20 grams of crude resin yielded 8·3 per cent. of material insoluble in boiling petroleum ether, the solution yielding 71 per cent. of yellowish crystals with a melting point of 61° C. Recrystallisation yielded a paler product and gave the impression that pure crystals would be white. The melting point of the recrystallised material remained, however, 61° C. A varnish was prepared from these crystals. (See Trial 3 below.)

Varnish Trials

The following trials were carried out:

Trial 1

10 grams resin.
30 grams linseed oil.
30 grams gold size (B.S.S. 311).

The resin and oil were warmed on the water bath until all the resin had dissolved. The gold size was then added and the varnish filtered.

The varnish was stable on standing. A film painted on tin was surface dry in 17 hours. After stoving for 1 hour at 120° C. it yielded a rather soft film of high gloss. The flexibility of the film was satisfactory. After standing for 4 days the film had toughened considerably.

On continued standing the varnish deposited a small amount of foots.

TRIAL 2

10 grams resin.
30 grams linseed oil.
30 grams gold size.

The resin was run at 250° C. for 10 minutes. 30 grams of linseed oil at 200° C. were added, and the mixture kept at 200° C. for 5 minutes. On cooling to about 150° C. 30 grams of gold size were added. There was a very small amount of residue, and the varnish was filtered. The varnish was stable on standing. The point of this experiment was not so much to run the resin as to incorporate the oil at a high temperature.

A film painted on tin was surface dry in 17 hours. After stoving for 1 hour at 120° C. it yielded a fairly hard film of high gloss, fairly satisfactory to scratch and satisfactory as regards flexibility. The film toughened somewhat on standing for a further 4 days.

(*Note.*—In one film on painted wood a certain amount of cracking of the film was observed. This was thought to be due to too thick a film.)

TRIAL 3

5 grams crystals isolated by petroleum ether.
15 grams linseed oil.
15 grams China wood oil.
30 grams gold size.

These four ingredients were mixed and warmed on a water bath until solution was complete.

The varnish was stable on standing.

A film painted on tin was surface dry in 17 hours. After stoving for 1 hour at 120° C. it yielded a fairly hard film of high gloss. This film was tougher than those produced in Trials 1 and 2 and gave satisfactory scratch test under a load of 1,000 grams. The flexibility of the film was satisfactory. The film toughened considerably on standing for a further 4 days.

TRIALS 4 AND 5

10 grams resin.
10 grams East African copal
30 grams linseed oil.

In an attempt to increase the hardness of the varnish film, a mixture of the resin with East African copal was run at 280° C. for 10 minutes, and the linseed oil incorporated at 240° C. (Trial 4). At first the linseed oil was successfully incorporated, but on further additions the resins were thrown out and the experiment had to be abandoned.

Trial 5 was a similar experiment running the gums at 300° C., but this also failed.

TRIALS 6 AND 6A

		Trial 6.	Trial 6A.
Resin . . .	*grams*	25	12·5
Linseed oil . .	,,	40	20
Thinners . .	,,	30	25
Driers . .	,,	5	3

The thinners in Trial 6 consisted of white spirit 4 parts, naphtha 1 part. The thinners in Trial 6A consisted of white spirit 3 parts, turpentine 2 parts. The driers consisted of a 5 per cent. solution of cobalt, lead and manganese novenate in white spirit.

In both cases the resin and oil were warmed on the water bath, and the thinners and driers added slowly. Both gave satisfactory solutions in the hot, the resulting solutions being much paler than the varnishes prepared in previous trials. On cooling, however, the varnish to formula 6 solidified out completely, while 6A remained stable.

A film of the filtered varnish 6A painted on tin was surface dry in 17 hours, yielding a surface that was rather "bitty." On forced drying for 1 hour at 120° C. the film was not as tough as films in Trials 1, 2 and 3 but showed good flexibility. The film toughened considerably on standing for 4 days.

TRIAL 7

15 grams resin.
30 grams linseed oil.
15 grams China wood oil.
5 grams driers (as in Trial 6).
40 grams thinners.

The thinners in this trial consisted of equal parts of white spirit and turpentine. The varnish was prepared in the same manner as in Trial 6. It was stable on standing.

A film of the filtered varnish painted on tin was surface dry in 17 hours. On forced drying at 120° C. for 1 hour the film was fairly tough and satisfactory as regards flexibility. A marked increase in toughness was shown on standing for a further 4 days.

TRIAL 8

20 grams resin.
40 grams linseed oil containing driers.
20 grams thinners (equal parts of white spirit and turpentine).

The driers (cobalt, lead and manganese novenate) when mixed into the varnish represented 1 per cent. of the whole.

The resin was run at 300° C. for 10 minutes. When the temperature of the resin had dropped to 240° C. the oil (at the same temperature) was slowly added and the mixture maintained at 250° C. for 5 minutes. Finally the thinners were introduced at about 150° C. The varnish was filtered and was found to be stable on standing even at low temperatures (5° C.).

A film of the varnish on tin was surface dry in 17 hours, and on

stoving for 1 hour at 120° C. was found to withstand scratch under a load of 800 grams. The film was satisfactory as regards flexibility. The toughness of the film increased on standing for 4 days.

TRIAL 9

60 grams resin.
90 grams "war emergency oil for paints."
50 grams thinners (xylene).
0·5 gram driers (cobalt, lead and manganese novenate).

(*Note.*—War Emergency oil for paints is described in British Standard 925 (1940). It consists of heat-treated genuine linseed oil or a mixture of not less than 75 per cent. by weight of heat-treated genuine linseed oil and other suitable heat-treated drying oil or oils.)

Since it was found that running at 300° C. appeared to increase the solubility of the "gum" in oil, it was decided to attempt to produce a varnish from the resin after running it at this temperature, using also "war emergency oil for paint" as the vehicle and a fairly volatile solvent as thinner, in this case xylene.

The resin was run at 300° C. for 15 minutes, the oil was added and the varnish held at 250° C. for 5 minutes. (The oil-resin mixture was stable at 5° C. after this treatment.) The mixture was allowed to cool, and the thinners added at 190° C.

The varnish was found to be stable on refrigeration overnight at 5° C.

The material was painted out on tin and found to be very slow in drying. The driers were therefore increased to 1 per cent. when the varnish was found to dry fairly well. A film on tin was surface dry in 17 hours. On stoving for 1 hour at 120° C. the film was fairly tough and flexible and yielded a high gloss. Scratch test gave a figure of 1,000 grams.

Remarks

It was found from the above trials that stable varnishes could be produced from the resin under the following conditions:

(1) By incorporating a proportion of gold size, type Q (B.S.S. 311), roughly 40 per cent. was used.

(2) By incorporating a proportion of turpentine (roughly 17 per cent. was found sufficient).

(3) By employing "war emergency oil," xylene thinners and driers as in Trial No. 9.

The varnish films throughout these trials, when dry, were less hard than those yielded by a copal varnish.

The colours of the varnishes obtained throughout these trials varied with the treatment. Trials 6A and 7 yielded varnishes which were a little darker than the linseed oil used in their preparation. Trials 1, 2, 3, 8 and 9 yielded darker varnishes, those which had received heat treatment being darkest.

Conclusions

It has been possible to produce stable varnishes with the resin under conditions outlined above. The varnishes had a good gloss but yielded dry films which were generally less hard than that given by a good copal. The flexibility of the films was, however, good.

Painted wooden panels, treated with the varnishes and exposed to air and sunlight over a comparatively short period of 10 days or so indicate that generally the films tend to harden on exposure, the gloss being maintained.

These preliminary varnish trials show that this resin can be used as an ingredient of varnishes for certain purposes, and it might be useful in the absence of better materials. Trials on a semi-commercial scale would be necessary before any final verdict could be given as to its value to the varnish-making industry.

APPENDIX

Report by Paint Research Station, Teddington, dated December 11, 1943

EUPHORBIA TIRUCALLI RESIN

A sample of this resin (10 lb.) was submitted by the Imperial Institute for examination as a varnish- and paint-making material.

General Examination

The resin was yellowish in colour and slightly opalescent; much of it was in the form of a fine dust.

The acid value of the lump resin was 9·5, and of the dust 9·0; the saponification value of the lump resin was 37. (Earlier samples of *Euphorbia resinifera* resins received and examined in 1939 gave acid value figures of 3·5–7·9, and a saponification value of 47·0.)

The melting point of the resin (capillary tube method) was 57°-60° C.; on heating to 100° C. it frothed, losing a small amount of water.

The resin dust had no obvious physiological effects on the workers in the laboratory, although prolonged exposure to it caused some irritation of the mucous membrane, similar to that produced by copal or fumes from heated colophony.

Solubility in Solvents

The resin dissolved rapidly (on warming) in benzene and other aromatic hydrocarbons, and less readily in ethyl alcohol. Solutions (3 parts solvent to 1 part resin) in turpentine were slightly cloudy even while hot, and those in white spirit were more so.

After standing for a few hours the 25 per cent. resin solutions were examined. Whilst the benzene solution remained clear, a

comparatively large amount of deposit, bulky and gelatinous in character, was obtained from the solution in white spirit and a lesser quantity of similar material from that in turpentine; from the alcoholic solution, a small amount (about 1/20 of the weight of the resin) of a crystalline substance was deposited. Precipitation of this material from the alcoholic solution was virtually complete after 3 hours, in the sense that no further deposit was obtained on prolonged refrigeration or evaporation of the solution.

Preparation and Testing of Spirit Varnishes and Paints

For this purpose solutions of the resin in ethyl alcohol (equal parts by weight) were made by warming; in one case varnish films were prepared before the solution had stood long enough to cloud or to throw down the crystalline deposit to which reference has already been made, while in another case the crystallisation was allowed to take place, and the clear supernatant liquor used. Films of both types remained clear even after prolonged refrigeration. If air-dried they remained slightly soft and tacky, but a brief period of stoving at 50° C. eliminated these defects. Adhesion to metal was reasonably good, but flexibility and hardness were poor, scratch-hardness tests gave figures of 150-250 gms., which is very low. There was little difference in any physical property between the films prepared from the whole solution or from the solution after separation of the crystalline material.

For paint tests, solutions were made from one part of resin in two parts by weight of ethyl alcohol, and as before, in one case, the whole solution was used, and in another case the supernatant liquor after separation of the crystalline material. The solutions were pigmented with titanium dioxide (using equal parts by weight of solid resin and pigment) by grinding in a ball mill. The paints so produced were touch-dry in about 1 hour under laboratory conditions. Accelerated weathering for 250 hours of the standard cycle indicated that the absence of the crystalline material improved the durability at least of the paints tested. The difference in the amount of checking and chalking of the two films was quite noticeable. Both paints when applied over a bitumen coating showed a fair degree of bleeding and both showed rather poor wear-resistance in laboratory road wear tests.

Preparation of Oil Varnishes

Although it was possible to prepare stable oil varnishes from the resin with drying oils, the conditions for stability appeared to be rather critical. Thus, on simple heating with drying oils (linseed, dehydrated castor, tung and some fish oils were used), the resin dissolved but was largely re-precipitated on cooling; and cold-cut oil varnish media, although clear, gave soft and "cheesy" films, indicating incompatibility of the oil and resin after evaporation of the solvent. On the other hand, stable varnishes were produced

by "running" the resins at 300° C. and adding the oil at 240° C. Proper selection of thinner was also important, the use of some proportion of turpentine or aromatic hydrocarbons in addition to white spirit being desirable.

After consultation with the Imperial Institute, it was decided to prepare the following types of varnishes for test:

1.	Resin	20 pts. by wt.
	Linseed oil	40 ,, ,, ,,
	White spirit: turpentine (1 : 1)	20 ,, ,, ,,

Driers: Lead 1 per cent., Cobalt 0·05 per cent., Manganese 0·05 per cent. calculated as metal on the oil and introduced as naphthenates.

The resin was run at 300° C. for 10 minutes, cooled to 240° C. and the oil (also at 240° C.) added. Thinners and driers were added at 150° C.

2.	Resin	60 pts. by wt.
	Linseed oil: Herring oil (3 : 1)	90 ,, ,, ,,
	Xylene	50 ,, ,, ,,

Driers as above.

The resin was run at 300° C. for 15 minutes, the oil added and the varnish held at 250° C. for 5 minutes. Thinners and driers were added at 150°.

3.	Resin	60 pts. by wt.
	Linseed oil	60 ,, ,, ,,
	White spirit: turpentine (1 : 1)	50 ,, ,, ,,

Driers as above: cooking procedure as No. 1.

Since all three varnishes were found to dry very slowly (see below), the three preparations were repeated to give varnishes with increased drier content, i.e. 1·0 per cent. lead, 0·1 per cent. cobalt, and 0·1 per cent. manganese (metal on oil) in each case. These varnishes are called 1X, 2X and 3X, and carry driers up to the limit of practical use; indeed, higher drier contents would be expected adversely to affect durability.

General Characteristics of Oil Varnishes

Varnish No. 3 dried more satisfactorily and gave harder films on air-drying than Nos. 1 and 2, but it produced a rather heavier sediment. In no case was sedimentation increased by refrigeration.

Varnishes Nos. 1 and 2 required 6 to 7 days for complete air-drying, and No. 3 required 3 to 4 days; all, however, gave reasonably tack-free films after one hour's stoving at 120° C. Varnishes Nos. 1X and 2X, i.e. those with increased drier content, air-dried in 3 to 4 days (a time which must be regarded as still outside the sphere of practical application), whilst varnish No. 3X air-dried in 36 hours.

The three varnishes gave the following scratch-hardness figures determined by the Air Ministry (D.T.D. Spcns.) method:

Varnish No.	Scratch Hardness. Air-dried.	Scratch Hardness. Stove 1 hr. 120°C.
1	600 gms.	1250 gms.
2	500 ,,	1100 ,,
3	1000 ,,	800 ,,

Bend-test figures were all very poor; only one panel, viz., the air-dried varnish No. 1 survived bending over 1 in. dia. mandrel; all the others cracked but did not flake over the 2 in. and $1\frac{3}{8}$ in. dia. mandrels respectively.

Paint-making

Paints were made from varnishes Nos. 1X, 2X and 3X, i.e. those with the large drier content, by grinding in a ball mill with titanium dioxide using equal parts of pigment and non-volatile content of the varnish. Titanium dioxide was chosen as the pigment most likely to reveal loss of binding properties on weathering as usually disclosed by chalking. The paints based on varnishes Nos. 1X and 2X air-dried in about 48 hours, and that based on varnish No. 3X in about 24 hours; all gave glossy and fairly hard films. Similar films obtained by stoving for 1 hour at 120° C. were hard but showed considerable yellowing.

After accelerated weathering of painted mild steel panels for 250 hours of the standard cycle, all the paints and varnishes showed moderate or severe water-spotting, the air-dried panels being considerably worse than the corresponding stove-dried panels. The paint based on varnish No. 3X also showed severe fine checking, whether air-dried or stoved. There was little rusting of the panels, and a noteworthy feature was the absence of chalking of the paints. This feature is to be attributed to the rather soft and somewhat sticky nature of the medium, and should not, at least at this stage, be regarded as evidence of specific high durability.

Emulsion and Cold-cut Media

A solution of equal parts of resin and benzene gave on emulsification with an equal volume of 10 per cent. ammonium oleate solution a thick creamy emulsion which was pigmented with red iron oxide, using two parts of pigment to one of resin. Unless gelatine was added, this paint tended to become granular on standing, and in any case the emulsion broke on the paint being brushed out. The same type of failure was experienced with an emulsion made from the resin, i.e. without solvent, in which case the resin was rendered fluid by heat. Emulsions of the normal oil-bound water paint type based on varnishes 1, 2 and 3 and 1X, 2X and 3X were not attractive.

Emulsions made from cold-cut varnishes incorporating the resin, raw linseed oil, blown linseed oil or linseed stand oil usually

clotted or reversed on standing and could only be pigmented with difficulty. One such cold-cut varnish based on equal parts of resin and linseed oil with 0·05 per cent. cobalt as drier and thinned with benzene to brushing consistency was pigmented with red iron oxide but gave very soft "cheesy" films with poor adhesion of little value.

Conclusions

Euphorbia resin/linseed oil varnishes and paints of the general type described above are rather too slow-drying at ordinary temperatures for general use, even with abnormally high drier content. This defect can, however, be ameliorated by stoving. Apart from water sensitivity which was shown by all the varnishes, the weathering characteristics of both the varnishes and paints, whether films were air-dried or stoved, were reasonably good; an interesting feature was the absence of chalking of the white paint tested but the importance of this should not be exaggerated since it may be due to the soft, somewhat sticky nature of the compositions under the surface skin.

The resin might find a limited application in spirit varnishes as an alcoholic solution. It is difficult to suggest with confidence a prospective use. Whilst supply conditions for the more orthodox materials are difficult, manufacturers would be disposed to experiment, and it is conceivable that such resin might find a limited use in the linoleum, oilskin and leather cloth industries, or possibly even as a paper size.

ARTICLE

PYRETHRUM CULTIVATION IN KENYA[1]

By R. S. Ball, M.A., Dip. Agric. (Cantab.), A.I.C.T.A.,
Agricultural Officer, Kenya Colony

Introduction

The cultivation of pyrethrum in Kenya has expanded very rapidly within recent years, as illustrated by the figures given below. During the war a still larger increase has taken place.

Output of Kenya Pyrethrum 1934-1939

Years.	*Tons.*
1934	54·5
1935	321·6
1936	1,078·2
1937	989·2
1938	1,864·1
1939	2,869·3

[1] Reprint of an article (revised and amended, 1943), issued by The Kenya Farmers' Association (Co-operative) Ltd., and received through the courtesy of the Department of Agriculture, Kenya.

The expansion of the pyrethrum industry in Kenya is in large measure due to the high toxicity of the Kenya flowers, which has enabled them to secure a premium on the world's markets, together with high average yields per acre and efficient methods of preparation and marketing of the product.

The crop will grow under a wide range of conditions in Kenya, but yields best at the higher altitudes over 7,500 ft., where the rainfall is fairly evenly distributed throughout the year, without a prolonged dry season. In such areas the crop can be regarded as of permanent value, occupying an important place in the economy of the farm, whereas at altitudes below 7,500 ft. it is a valuable sideline; but it is doubtful whether its cultivation under 7,000 ft. is justified except during periods of exceptionally high prices or where other factors such as heavy rainfall and low temperatures may in part compensate for the other disadvantages of a low elevation. Unlike most other plantation crops, pyrethrum can be established at a comparatively low cost per acre and can easily be eradicated if prices or other factors cease to justify cultivation, and for this reason there is always likely to be a considerable fluctuating acreage of marginal land devoted to the crop, in addition to those areas at the higher elevations where it will probably occupy a permanent place in the economy of the farm.

The crop flourishes on a very wide range of soils throughout the Colony, but on land where waterlogging is likely to occur due to hard pan close to the surface or its low-lying character, the plants will rapidly die out during the rainy season. Soils which are very loose in character and on which rooting is difficult, such as rich humus forest soils where the land has been recently cleared, do not give such high yields owing to the difficulty of maintaining a good stand of the plants and a tendency to grow vegetation rather than to produce flowers. Furthermore, the weed growth on such soils is likely to be very heavy, and constant weeding tends also to reduce the stand of the plants.

The highest yields in the Colony have usually been obtained on the top of the open ridges in the high altitude areas in which the soil is a medium loam, free-draining and easy to cultivate and where the weed growth is not usually very heavy, and in such areas yields as high as 1,200 lb. per acre of dry flowers per annum have been recorded over considerable acreages.

The value to the farm of a crop producing a high return per acre with relatively low initial capital expenditure cannot be overstressed since in those areas where it is likely to prove of permanent value it will tend to reduce the economic size of the farm and also provides a rotation crop in areas where few such exist. While it may seem paradoxical to state that a plantation crop can be regarded as occupying a place in a crop rotation, yet it will be shown that it is definitely desirable to replant a percentage of the acreage annually, and hence it can occupy a place in a crop rotation. In

those high altitude areas, where wheat has hitherto been the predominant cash crop, the advantage of pyrethrum to rest land which may have become infected with "Take-all" disease cannot be overstressed.

The chief conditions necessary for the successful cultivation of pyrethrum may be summed up as follows:

1. High altitude—over 7,500 ft., with evenly distributed rainfall of 40-45 in.
2. Soils on which weed growth is not excessively heavy, and on which the plants can obtain a firm roothold.
3. Absence of conditions likely to produce waterlogging.
4. Moderate fertility—excessive fertility in the soil is likely to produce heavy weed growth and growth of leaf at the expense of flowers, but some growers have made the mistake of planting the crop on poor soils with the idea of reducing weeding costs. This is, of course, a mistake, as it will lead to reduced yields.
5. Control of soil erosion. The crop is likely to suffer considerably from the effects of soil erosion, and it is essential to take the necessary preventive measures such as contour ridging, etc., more particularly where the soil is shallow.
6. The establishment of a good stand in the field. An indifferent stand will never produce a full crop. When the stand becomes reduced, it is necessary to plough out the plantation and replant.
7. Clean weeding. This is absolutely essential both within the plants themselves and in the rows between the plants.

Cultivation

Thorough cleaning and preparation of the land is essential, since it is not possible to perform thorough cultivation after the crop has been established and delayed attempts to eradicate couch usually involve the removal of a considerable number of plants. For this reason hand de-couching and burning should be performed if necessary, and several crops of couch may be removed by repeated ploughing, cultivation with spring-tined cultivators, collection and burning before the land is finally cleaned. In the case of old wheat lands germination of weed seeds by thorough cultivation should be effected. Deep cultivation (in excess of 6-8 in.) does not appear to be necessary for the crop, which is shallow rooted by nature, and a reasonably firm bed is desirable before planting out so as to secure a good stand. When the land has been cleaned it should be contour terraced prior to planting in order to prevent erosion of the soil. This is best effected by the construction of narrow base ridges which are on the usual variable grade recommended for arable crops, but in the case of exceptionally absorbent soils level base terraces may be employed. The banks should be approximately 5-6 ft. wide and about 18-24 in. high, with a shallow drain

3 ft. wide on the upper side. Pyrethrum can be planted over the banks, and their shape should be maintained when cleaning by drawing the soil upwards. It is estimated that a native can contour 30 yards of such a bank daily by hand with a jembie and shovel, so that the cost of protection per acre is relatively small.

It should again be emphasised that it is only advisable to construct level base terraces provided the soil is absorbent and heavy storms are not experienced. In an area of low rainfall the level base terrace is an advantage since its construction ensures that all the rain will remain on the field.

It is essential in the case of variable grade terraces to construct suitable outlets at the edge of the field to carry away the water which runs off, and in the construction of the terraces it is necessary to build them up well if they cross former gullies so that they may not break away during heavy rains.

Planting should be carried out in the main general direction of the contour ridges, but provided the land has been adequately protected by ridges there is no need to plant exactly on the contour. By following the general line of the contours cultivation up and down slopes will be avoided.

Manurial Requirements

Experiments on the application of fertilisers to pyrethrum have been in abeyance due to the war, but farming opinion is still divided on this question. Applications of superphosphate have in some cases been followed by increased weed growth, with a consequent increase in weeding costs and a reduction in stand due to these frequent weedings. In other cases farmers have found that such applications gave an increase in the numbers of flowers, individual flower size and an increase in yield of the plantation.

On poorer soils, or on land which has been under pyrethrum for a few years and which has been cleared and ploughed for replanting, preliminary trials with dusting the holes with bone meal or guano at the time of planting indicate that the young plants make a better and more vigorous growth.

The pyrethrum crop does not remove heavy quantities of plant foods. A 1000 lb. crop of dried flowers removes 17 lb. nitrogen, $25\frac{3}{4}$ lb. potash, $5\frac{3}{4}$ lb. phosphoric oxide and $4\frac{1}{4}$ lb. lime, amounts that would be supplied by 85 lb. sulphate of ammonia, 30 lb. superphosphate and 51 lb. sulphate of potash, or, taking war-time fertilisers, 175 lb. hoof and horn meal and about 200 lb. wood ash per acre.

Planting material

The two types of planting material used are either seedlings or root divisions from existing plants. A considerable diversity of opinion exists as to which are the best to use, but it would appear that it is usually easier to establish a field with seedlings since they

have a better root system and withstand transplanting better under unfavourable conditions than root divisions. At the same time, a considerable amount of labour and supervision is required for tending the seed beds, and seedlings do not come into flower so quickly after transplanting as root divisions. At the lower elevations, however, where a percentage of non-flowering or low producing plants are usually found in cultivations established from seedlings, it may be possible to eliminate these by selection of plants for root divisions which have shown ability to flower and yield well under the particular conditions prevailing.

(*a*) *Selection of root divisions.*—It is important to select material for root divisions carefully from high-yielding plants, and this applies particularly at the lower elevations. The common practice of removing every plant over a certain area for purposes of obtaining root divisions should not be encouraged, but more attention should be paid to the selection of planting material. The non-flowering or dark-green coloured "cabbage" looking plants should be discarded completely, and, generally speaking, the more silvery coloured and feathery leafed plants will be found the most desirable type to propagate. Material to be used for splitting should have all the flowering stems cut off before it is dug up, and attempts should not be made to obtain too many root divisions from one plant. Small spindly divisions with little or no root system will be found difficult to establish, and replanting and patching subsequently will be necessary. Care should be taken to ensure that every split (division) when planted has part of the root system of the parent plant and contains a due percentage of foliage. A large number of individual plants should be used to establish a plantation, and attempts should not be made to establish a plantation from one or two high yielding plants propagated repeatedly by root divisions. The reason for this is that the pyrethrum plant is self sterile, and it is necessary to have a large number of individuals in the field so as to ensure adequate pollination which is necessary in order to obtain a high pyrethrin content in the flowers. Also it is necessary to guard against selection of plants having flowers of low pyrethrin content.

(*b*) *Seedlings.*—A considerable number of farmers will continue to plant their plantations from seedlings on account of the greater ease with which they can be established in the field, more particularly during unfavourable conditions, and also the high cost of obtaining splits if it is necessary to buy when plants are not already available. *It is of importance to use seed the origin of which is known and which has been harvested from carefully selected material.* Limited supplies of seed from selected high pyrethrin content plants are now being produced by the Department of Agriculture, and these are distributed by the Pyrethrum Board of Kenya. Farm seed plots should be established from a large number of individual plants selected in the field for such characters as flower

size (size of centres), number of flowers, upright non-straggling habit and high pyrethrin content, and these should be planted all together in a plot by themselves and used for seed production. A large number of plants should be used for this purpose, so as to avoid any possibility of partial sterility through lack of sufficient numbers of individuals for cross-pollination.

The seed should be harvested when the disc florets have died and tend to fall off the flower head, exposing the greyish-brown seed. The seed should not be stored for long periods as it loses its viability fairly rapidly. One pound of seed is usually adequate to plant one to three acres in the field according to the spacing. The seed does not usually germinate more than about 50 per cent. in the seed bed, and germination is slow and irregular, taking about 12-14 days.

Seed-beds

The seed-beds should be made on well drained soil which is carefully and evenly levelled. Owing to the slow rate of germination of the pyrethrum seedlings, it is desirable to obtain a thorough germination of the weed seeds first before the pyrethrum seed is planted. Overhead shade should be provided for the seed-beds, and it is advisable to thatch the soil itself with a light covering of grass until the seedlings have germinated. The seed should be scattered lightly over the beds and covered with a very thin layer of soil and watered daily. The grass covering will be removed at about the 12th-14th day, when the majority of the seed has germinated. If any signs of damping off appear, the shade should be removed and the plants watered with water tinted with permanganate of potash. Pricking out of the seedlings about 3 in. × 3 in. apart is to be recommended, as this stimulates root development and will hasten the time at which they will come into bearing when transplanted into the field. Although this operation increases the labour costs, it is doubtless well worth while, since a return is secured much more quickly. It is important that the seedlings should be well grown before they are transplanted into the field, and should have at least 10-12 leaves. If smaller seedlings are transplanted, they frequently become buried with soil when heavy rain falls at the time of transplanting into the field, and flowering will of course be delayed.

Transplanting into the Field

A considerable amount of experimental work has been carried out on the correct spacing for pyrethrum, and it would appear that in the high altitude areas a square spacing of 2 ft. × 2 ft. is likely to give the most satisfactory results. On rich forest soils, however, where rooting is loose and weeding expensive, it is advisable to adopt a somewhat wider spacing between the rows, spacing the plants closer together in the rows. In this manner more mechanical

cultivation with oxen and donkeys can be performed, and there is less danger of loosening the roots of the plants. Under such conditions spacings of 2 ft. 6 in. or even 3 ft. between the rows, and 16-18 in. between the plants in the rows are recommended. Latterly, however, many farmers are adopting a narrower spacing in the row coupled with a wider inter-row spacing of 1½ ft. × 3 ft., planted on the contour. This spacing makes for ease of cultivation, cheapens weeding costs and lessens soil erosion.

The approximate numbers of plants required per acre of the more common spacings are as follows:

2 ft. × 2 ft.	11,000 plants per acre.
3 ft. × 1½ ft.	10,000 ,, ,,
3 ft. × 2 ft.	7,400 ,, ,,
3 ft. × 3 ft.	4,900 ,, ,,

At the lower altitudes (7,000 ft.-7,500 ft.), where growth is not so vigorous, a square spacing of 20 in. × 20 in. is recommended, except for rich forest soil conditions, when the spacings adopted should be similar to those previously recommended.

The fields should be carefully marked out prior to planting, and it may be desirable to leave paths at intervals to facilitate handling the crop. If, however, wide spacings between the rows have been adopted, this will not be necessary, and even with a 2 ft. × 2 ft. spacing is not essential.

If the field is being planted with splits, an entrenching tool should be used for digging the holes prior to planting out. Great care should be exercised in splitting up the plants to ensure that each split has a part of the parent root system, and the plants should be firmly planted in the ground and the soil well tamped round them. *Carelessness in firming the soil round the roots of the plant is a frequent cause for a poor stand subsequently due to high mortality.* In the case of seedlings, the holes can be prepared with a pointed stick, but care should be taken to ensure that the roots point properly downwards and soil is well consolidated round the plants. Approximately 10-14 boys will plant 1 acre daily, but it is work that requires the closest supervision and should not be unduly hurried. Failure to secure a good stand will result in low yields and a short life of the plantation. A certain percentage of plants, more particularly on the looser soils, are, however, likely to die due to defective root system or other causes, and such gaps should be replanted as soon as possible before the rest of the plantation has commenced to flower. If attempts are made to patch up fields which have come fully into bearing, the results are never likely to be satisfactory owing to the difficulty of establishing the replanted material and the slow rate at which they will come into production, due to the competition from mature plants.

Fields established from splits should, at the high altitudes, commence to flower approximately 14 weeks after they have been planted, while seedling material will probably take about 8-12

weeks longer. These periods are increased somewhat at the lower elevations, where a percentage of the plants established from seedling material may even remain for a period of one year before commencing to flower, and the same may apply to a percentage of the root divisions unless these have been very carefully selected. There is a considerable difference of opinion as to the advisability of cutting off the flowering stems when the young plants begin to flower in order to stimulate their vegetative growth. Provided, however, good sized seedlings or splits have been used originally, there is no particular advantage in adopting this practice, and picking of the flowers should commence as soon as possible.

Cleaning

As previously mentioned, it is absolutely essential to keep the crop clean both from weeds between the plants and in the plants themselves. A certain amount of mechanical cultivation can be performed with small ox cultivators pulled either by an ox or a donkey, the latter being more suitable for work between fairly close rows. While the plants are young, the majority of the weeding can be done in this manner, but care should be taken to remove all weeds growing in the plants themselves. The worst of such weeds is probably the sorrel (*Oxalis* spp.) which grows up in the plant and eventually kills it, thus shortening the life of a plantation considerably, and it is important to take care when planting from root divisions that these are free from the weed. Indigenous clovers also grow up in the plant and are extremely difficult to eradicate. On forest soils, where weed growth is heavy, it may be necessary to weed as frequently as every 14-17 days during the rains, but as a general rule the period varies from a month to six weeks or more. The use of a Dutch or turnip hoe as opposed to the jembie for weeding is encouraged, since it does not do so much damage and it is quite effective for the work, provided weeds are not allowed to grow much beyond the seedling stage, which is essential if the plantation is to yield well. Some farmers use Planet Junior hoes pushed by hand for weeding. These are quite effective for performing the work, particularly in the early stages of the life of a plantation, but should not be used exclusively owing to their tendency to encourage the formation of a pan. It is desirable that an established plantation should be given at least one cultivation with ox cultivators annually to burst up the soil on the surface which has become packed owing to the frequent treading during picking, etc., and the operation is best performed immediately after the plantation has been cut back. The cultivators should penetrate about 2½ in. below the surface, but not deeper; otherwise they would tend to loosen the plants in the soil.

Weeders often make the common mistake of drawing the soil away from the plant when hand weeding with a jembie, until eventually the plants tend to sit on a small cone of soil. This type

of weeding should be prevented since it exposes the roots. Beneficial results have been obtained by lightly running a ridging plough between the lines of plants along the contour; this has the effect of throwing the soil back to the base of the plants and also tends to prevent erosion.

Failure to keep pace with weed growth will sooner or later necessitate thorough deep weeding, which removes a large percentage of the plants. The acreage of pyrethrum which will be grown on any farm is therefore likely to be limited by the amount of labour available for cleaning and picking. Under average conditions one boy is continuously employed in cleaning approximately 5 acres, although this figure will vary very widely.

Picking

It is important that flowers should be picked when there is no external moisture on them, either dew or rainfall, which is likely to cause heating before the flowers are dried. Such heating would be deleterious to the colour and appearance of the dried product and also to its pyrethrin content. For these reasons picking should not be commenced early in the morning until the dew has dried off the flowers. The flowers should be picked into wicker-work baskets which permit of access of air at the sides so as to prevent heating, and if they are not removed to the drying plant for some time should be spread out on tarpaulins when the baskets have been filled. The average amount of flowers picked per day varies from 25-30 lb. fresh flowers, depending on the size of the crop and the nature of the labour employed, and amounts considerably in excess of this may be picked during the periods of heavy flush; while during the dry season the amount may fall to 12-15 lb. daily.

Observations carried out showed that pickings may range as low as 9 lb. per acre of dried flowers per picking to 250 lb. per acre dried flowers per picking during the heaviest flush periods in high altitude pyrethrum growing areas.

Great care should be exercised over the picking operations so as to ensure that flowers only at the correct stage of maturity are harvested, i.e. when at least 3-4 rows of disc florets are fully open, and that the picking of immature flowers and buds, which would result in the lowering of the pyrethrin content, is avoided. The flowers should not be packed tightly in the receptacles into which they are picked, but allowed to fall in loosely. Payment for picking is usually made on the basis of weight, and varied from ¾-1 cent. per lb. of fresh flowers, although the work can often be performed slightly more cheaply by the employment of monthly labour at a fixed wage who are given a minimum task of 25 lb. of fresh flowers daily, picking in excess of this amount being paid extra depending on the amount picked. Picking is performed roughly at fortnightly to three-weekly intervals throughout the flowering season, which may continue for 8-9 months of the year. It is important, however,

always to examine the flowers carefully in the field before commencing to pick, rather than to attempt to follow any definite time interval.

Flowers should be removed to the drier as rapidly as possibly after picking. Artificial driers of the Ainabkoi type are the most popular at the present time, although these are being continually improved to make them more efficient and to produce a uniform sample of high pyrethrin content.

Cutting back

At the end of the flowering season the pyrethrum plants have a large number of dead flowering stems, and it is desirable to cut these back before the onset of the next growing rains. The level to which the plants should be cut back has been a matter for dispute, and for this reason experiments have been carried out to determine the correct method. The treatments adopted were as follows:

1. Control—Uncut.
2. Cut high—Flowering stems only removed.
3. Intermediate—Half foliage cut in case of tufted plants and remainder of plants cut half through.
4. Cut to ground.

Half of the area was also again cut in the middle of the flowering season to test whether it was possible to alter the time of flowering by cutting at periods other than before the onset of the rains. Results of this indicated that it is definitely inadvisable to try to alter the time of flowering by cutting at seasons other than the normal dry or dormant season. Results of the trials of different methods of cutting back are appended below:

	Cut once in dry season. *Lb. dry flowers per acre.*	All cut high again during rains. *Lb. dry flowers per acre.*
Control . .	1,155·5	417·0
Cut high . .	1,612·6	521·2
Intermediate .	1,213·7	424·6
Cut to ground .	877·1	294·0

The plants which are cut to the ground have never grown to the same size, and it would appear that this treatment would only be desirable if it were intended to rejuvenate an old plantation in order to permit of more thorough cultivation.

Yields

Yields vary very greatly throughout the pyrethrum growing areas, but are influenced largely by altitude and the nature of the soil, the highest yields being obtained at altitudes over 8,500 ft. on soils which are of a medium loam character. Under these conditions, yields of 900-1,000 lb. of dry flowers per acre per annum are sometimes obtained, while at lower elevations down to 7,000 ft.

yields in the neighbourhood of 500-600 lb. of dry flowers can be obtained. On rich forest soils with a very high humus content the yields will be lower, say in the neighbourhood of 550 lb. per acre at 8,000 ft.

Though the foregoing yields are commonly obtained, yields for the Colony have been on a lower scale. It is not possible to give exact figures because a proportion of newly planted acreage is always included in the statistics, but the average appears to have varied generally between 300 and 600 lb. per acre in different years, the over-all acreage to date being in the region of 400 lb. per acre per annum.

Life of a Plantation

The useful bearing life of a plantation will vary considerably with soil, altitude, rainfall and other factors. Except, however, in the highest altitudes the life of the plantation will probably be from 3 to 5 years since considerations of weeding, reduction in stand, and compaction of the soil, will probably render it desirable to replant before this age is reached. The chief indication of a need for re-establishment is a reduced stand, with consequent severe reductions in yield and increased weeding costs. It is essential therefore that a definite replanting programme should be adopted every year, the percentage to be replanted being based on the average useful life of a field for the particular conditions obtaining. Thus on a loose forest soil where the useful life may be only three years, it will be necessary to replant about 33 per cent. of the acreage annually, whereas in the high altitude areas on the tops of the ridges, 15 to 20 per cent. will be sufficient for annual replanting. It is highly problematic if, in a well looked after pyrethrum plantation, the pyrethrin content decreases with increasing age. Flowers taken from a plantation eleven years old compared extraordinarily well in pyrethrin content with flowers from an adjacent new plantation. At the Scott Agricultural Laboratories in a plot six years old, there has been no significant loss in pyrethrin content. It has also been widely stated that flowers from splits have a lower pyrethrin content than the parent plant. This is one of the many untrue legends pertaining to the growth of pyrethrum. Flowers from splits are as good as the flowers from the parent plant.

There is one proviso covering these statements—they apply to good farming practice. If a field is allowed to become weedy, then one may expect, with increasing age, a decrease in the pyrethrin content—the plants are not healthy. Again, if splits are badly planted and not looked after, then a lower pyrethrin content will accrue.

It is suggested that when pyrethrum has been removed from a plantation, it should not be replanted immediately, but other crops, such as peas or cereals, should be planted for a period of one year

or more, so that weeds such as sorrel can be effectively destroyed, and also other types of weed largely prevalent in pyrethrum.

This article deals with the cultivation of pyrethrum only and not with the drying of the crop. An article on the latter was published in the *East African Agricultural Journal* for January 1937, and plans and specifications of the Ainabkoi Drier, the type recommended by the Department of Agriculture and the Pyrethrum Board, are obtainable from the Kenya Farmers' Association (Co-operative) Ltd., Nakuru.

NOTES

Obituary.—Sir David Prain.—Lieutenant-Colonel Sir David Prain, C.M.G., C.I.E., F.R.S., died on March 16 at his home, The Well Farm, Whyteleafe, Surrey, at the age of 86, and so passed a botanist of world-wide fame, and one of the most illustrious and lovable men ever associated with the Imperial Institute.

Sir David came to the Institute after he had served in India and at Kew.

After graduating M.A. at Aberdeen and taking his M.B. at Edinburgh with highest honours, Prain joined the Indian Medical Service in 1884. Soon afterwards he was appointed curator of the herbarium and library at the Royal Botanic Gardens at Calcutta, and subsequently superintendent of the garden, and finally director of the Botanical Survey of India. In this period Prain's achievements in the botanical world have been acknowledged as outstanding. They included control of the cinchona cultivation in India, on which subject Prain became a great authority.

On returning to this country Prain was appointed director of the Royal Botanic Gardens, Kew, in 1905, which post he held for 17 years.

In 1926, when the Imperial Institute underwent reorganisation, Sir David accepted the appointment as first chairman of the newly-formed Advisory Council on Plant and Animal Products, and also became chairman of two of the committees appointed by the Council, those on Tanning Materials and on Hides and Skins. He attended daily at the Institute, and in an advisory capacity was regularly consulted by the Principal of the Department. The wealth of knowledge and experience possessed by Sir David were thus enlisted in the service of the Institute with highly successful results. His wisdom in advising on administrative matters was a valuable feature, and in approving or correcting Sir David always spoke in the kindliest tone, and with sympathy and appreciation for the views of others. In working with him one felt that he was a power for good and an unfailing source of advice in the hour of need. It is therefore not surprising that those who came in contact

with him were deeply sensible of great admiration for his genius and of well founded love for his truly Christian character.

Sir David retired from his duties at the Institute in 1936 at the age of 79.

Sir John Farmer.—The death of Sir John Farmer, F.R.S., on January 26, 1944, in his 79th year, severed a connection of the Imperial Institute with another eminent botanist who rendered valuable service to the Institute during an important period of its history.

John Bretland Farmer, a pupil of Isaac Bayley Balfour of Oxford, was destined to become one of the distinguished group of botanists who, following the lead of Bayley Balfour, modernised botanical science in this country. After teaching at Oxford as demonstrator in the University, where he was elected to a fellowship of Magdalen College, he succeeded the late Dr. D. H. Scott as assistant professor of botany at the Royal College of Science, South Kensington, and was appointed to the full professorship in 1895. In 1907 he became professor of botany and director of the biological department of the Imperial College of Science and Technology, in which the Royal College of Science had become incorporated. He retired in 1929 after thirty-seven years' service and was made Professor Emeritus.

Farmer was a first-rate investigator, and it became a lifelong inspiration to have worked under him. While primarily devoted to the purely scientific aspects of the subject he recognised to an unusual degree the practical relationship between botany and the plantation, agricultural and other industries dependent upon plant life, and was convinced of the important help which men trained in general botany and specialising in plant physiology, pathology and genetics could render to those industries. This conviction provided the basis of the remarkable development of Farmer's department which became a training ground for the many economic botanists which left his laboratories for posts at home and abroad, notably in the plantation rubber industry and in tropical agriculture. During the inter-war period Farmer served on many official and other committees concerned with economic botany. He was a member of the Advisory Council of the Department of Scientific and Industrial Research from 1920 to 1926, and was the first chairman of the Forest Products Research Board. With Mr. L. G. Killby he was responsible for the establishment in Trinidad of the Cotton Research Station of the Empire Cotton Growing Corporation and the associated scheme of post-graduate studentships, and took an important part in the work of the Colonial Office Committee which reorganised the recruitment and training for the colonial agricultural service. Farmer was actively associated with the establishment of the Imperial College of Tropical Agriculture in Trinidad, of which he was a governor.

In these circumstances it was natural that Farmer's assistance should be sought in connection with the reorganisation of the Imperial Institute in 1925 and that he should be appointed to the Governing Body of the Institute, as the representative of the Royal Society, and to the Advisory Council of the Plant and Animal Products Department on which bodies he served from 1925 to 1931. He took a lively interest in this work, an interest enhanced by the knowledge that since 1903 members of his own staff and old students from his laboratories had been appointed to the scientific staff of the Institute. Reference must also be made to the keen interest taken by Sir John Farmer in the research work on rubber carried out at the Imperial Institute under the auspices of the Ceylon Rubber Research Committee and, later, the London Advisory Committee for Rubber Research (Ceylon and Malaya), of which Committees he was an active member for about ten years.

Experiments on the Recovery of Sugar-Cane Wax in South Africa.—In this BULLETIN, 1943, **41**, 86, an account was given of work on the extraction of sugar-cane wax carried out in the United States. Experiments on similar lines have also been made recently under the auspices of the Wartime Research Division of the Department of Commerce and Industries, Union of South Africa. A copy of the report on these experiments has been kindly forwarded to the Imperial Institute by the South African Senior Trade Commissioner in London, and is reprinted below. The investigation was conducted under the direction of Dr. F. J. Tromp by Mr. Burger, of the Division of Chemical Services, and Dr. Rapson and Miss Sichel, of the Wartime Research Staff.

The experiments had as their object a more economical method of recovery than the old process of direct extraction of the dried cake in a modified Soxhlet apparatus, a process which is now further handicapped by the low wax content of the present filter press cakes.

The first experiments were conducted on the raw juice when various methods of flotation and solvent extraction were attempted. Although some flotation froths showed an appreciable concentration in wax content the recoveries were very poor. Of special interest in the flotation experiments may be mentioned the froths collected at boiling point, which contained up to 33 per cent. of wax.

Attention was next turned to the filter press cake itself. For various reasons the wax content of the cakes had dropped to an average of 4-7 per cent., making it highly advisable to effect a preliminary concentration before proceeding to a solvent extraction. After various unsuccessful flotation experiments in the cold, at elevated temperatures and in different *p*H media, a wet-screening process was finally developed whereby the cake is separated into a coarse 60 mesh portion containing about 2 per cent. of wax and a fine 60 mesh portion which contains 14-15 per cent. of wax. The overall recovery is in the neighbourhood of 82 per cent.

A few preliminary pilot plant runs have already been made in Pretoria at the Fuel Research Institute, but a three months continuous operation is contemplated for the coming cutting season, after which more detailed results will be available.

Briefly the process is as follows:

The wet filter press cake from the Oliver-Campbell filters is made into a slurry with water and screened wet. The equipment used consisted of a vertical cylinder of about 12 in. diameter of 60 mesh gauge, reinforced by heavier mesh backing mounted in a container about 24 in. diameter. In the gauge cylinder rotated a vertical shaft carrying propellor agitators preventing settling, wet filter cake was fed in at the top, and a continuous circulation of water maintained through the screen to a large settling tank. Periodically the coarse material was discarded and the fines collected. The fine 60 mesh material is then settled, filtered and extruded through $\frac{1}{8}$ in. apertures into rods and dried. These rods made from a cake derived from a juice which has been clarified with lime in the sugar mills, are compact and dry easily, and are extracted in a screw extractor with a counter-current of benzol at 70° C. Using a benzol to rods ratio of 2·5 to 1 and $1\frac{1}{2}$ hours extraction cycle, a screw with 8 ft. effective extraction length gave a 95 per cent. recovery of the wax in the rods.

The crude wax is unfortunately very dark in colour and somewhat soft so that a high-grade product can only be obtained by further refining. It has been found possible to separate the crude into pale and dark fractions, by heating with bone char and fractionating in a 90 : 10 alcohol-benzol mixture.

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AGRICULTURE

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The Spray-Drying of Pharmaceutical Products. Part II. Certain Inorganic Salts. By K. Bullock and J. W. Lightbown. Part III. Digitalis, Adrenaline and Ascorbic Acid. By K. Bullock, J. W. Lightbown and A. D. Macdonald. *Quart. J. Pharm.*, 1943, **16**, No. 3, 213-221; 221-226.

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Assay of Oregon Ergot. By E. T. Stuhr, B. E. Christensen and E. Wong. *J. Amer. Pharm. Assoc., Sci. Ed.*, 1943, **32**, No. 9, 241-244.

Some Observations on Australian-grown Papain. By W. J. Ellis and F. G. Lennox. *J. Coun. Sci. Industr. Res. Aust.*, 1943, **16**, No. 3, 166-172.

Antibacterial Substances—Penicillin. *Chem. Engng. News, News Ed.*, 1943, **21**, No. 17, 1430-1434, 1468.

A Study of the Assays of the Powdered Extracts of Certain Solanaceous Drugs. By H. V. Gilliland, K. L. Kaufman and H. Bang. *J. Amer. Pharm. Assoc., Sci. Ed.*, 1943, **32**, No. 9, 236-241.

Stramonium Collecting. By J. C. F. Hopkins. *Rhod. Agric. J.*, 1943, **40**, No. 5, 293-299. Gives directions for collecting, drying and packing the leaves of *Datura stramonium* and *D. tatula*.

Dyes

Indigenous Vegetable Dyestuffs for Pulp and Paper. By S. V. Puntambekar and P. C. Batra. *Indian For. Leafl. No.* 44 (*Utiliz. and Chem.*) *For. Res. Inst.* Pp. 12, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1943.) Price As. 6.

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Effects of Phosphorus Supplements on Cattle Grazing on Range Deficient in this Mineral. By W. H. Black, L. H. Tash, J. M. Jones and R. J. Kleberg. *Tech. Bull. No.* 856, *U.S. Dep. Agric.* Pp. 23, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.)

Beef Cattle in Peace and War. By D. M. S. Watson. *Emp. J. Exp. Agric.*, 1943, **11**, Nos. 43 and 44, 191-228.

Investigations on the Use of Irish Moss in Canning of Meat. By E. J. Reedman and L. Buckby. *Canad. J. Res.*, 1943, **21**, No. 11, Sec. D., 348-357.

Drying of Meat. Rate of Dehydration of Uncooked Cured Ground Meats. By E. C. Ritchell, E. L. Piret and H. O. Halvorson. *Industr. Engng. Chem., Industr. Ed.*, 1943, **35**, No. 11, 1189-1195.

The Chemical Composition and Nutritive Value of Milk and Milk Products. By S. K. Kon. *Chem. and Industr.*, 1943, **62**, No. 51, 478-481.

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Production of Clarified Butter, Problem of Present Interest. By E. Gasser. *Int. Rev. Agric.*, 1942, **33**, No. 12, 435T-455T.

New Way to Dehydrate Cheese. *Food Industr.*, 1943, **15**, No. 10, 80-81.

Preparation of Starter for Cheese, Buttermilk and Butter. By G. H. Wilster and F. E. Price. *Bull. No.* 379, *Oregon Agric. Exp. Sta.* Pp. 24, 9×6. (Corvallis: Agricultural Experiment Station, 1940.)

Swine Breeding Research at the Regional Swine Breeding Laboratory, Ames, Iowa. By W. A. Craft. *Misc. Publ. No.* 523, *U.S. Dep. Agric.* Pp. 14, 9×6. (Washington, D.C.: Superintendent of Publications, Government Printing Office, 1943.)

The Fattening of Pigs on Swill Alone: a Municipal Enterprise. By J. Lovatt, A. N. Worden, J. Pickup and C. E. Brett. *Emp. J. Exp. Agric.*, 1943, **11**, Nos. 43 and 44, 182-190.

Diseases of Sheep and Goats. By M. S. Shahan and W. T. Huffman. *Frms.' Bull. No.* 1943, *U.S. Dep. Agric.* Pp. 59, $9\frac{1}{2} \times 6$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 10 cents.

Studies in the Biology of the Skin and Fleece of Sheep. 1. The Development and General Histology of the Follicle Group in the Skin of the Merino. 2. The Use of the Tanned Sheepskin in the Study of Follicle Population Density. 3. Notes on the Arrangement, Nomenclature and Variation of Skin Folds and Wrinkles in the Merino. By H. B. Carter. *Bull. No.* 164, *Coun. Sci. Industr. Res. Aust.* Pp. 59 + 4 plates, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1943.)

Battery Management of Chicks and Layers in Hawaii. By C. M. Bice and B. A. Tower. *Circ. No.* 19, *Hawaii Agric. Exp. Sta.* Pp. 23, 9×6. (Honolulu: University of Hawaii, 1942.)

Cod-Liver Oil and Ultra-Violet Irradiation for Intensively Reared Chicks. By D. J. G. Black. *J. Minist. Agric.*, 1943, **50**, No. 9, 419-421.

The Production of Canned Precooked Chicken. By E. J. Reedman. *Canad. J. Res.*, 1943, **21**, No. 10, Sec. D, 324-331.

Dried Whole Egg Powder. VI. Effect of Storage Temperature and

Gas Packing on Keeping Quality. By W. H. White, M. W. Thistle and M. Reid. *Canad. J. Res.*, 1943, **21**, No. 9, Sec. D, 271-276.

Dried Whole Egg Powder. VII. Effect of Temperature and Moisture on the Bacterial Content of Liquid and Dried Egg. By N. E. Gibbons and C. O. Fulton. *Canad. J. Res.*, 1943, **21**, No. 10, Sec. D, 332-339.

Rabbits for Flesh and Fur. *Adv. Leafl. No.* 161, *Minist. Agric., Lond.* Pp. 4, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: H.M. Stationery Office, 1943.) Price 1*d*.

Annual Report of the Leather Industries Research Institute, Rhodes University College, Grahamstown, South Africa, for the year ended October 23rd, 1943. Pp. 29, $9\frac{3}{4} \times 7\frac{1}{2}$. (Grahamstown, South Africa: Leather Industries Research Institute, 1943.)

Leather. By D. Jordan-Lloyd. Pp. 31, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Royal Institute of Chemistry, 1943.)

Conserving Hides—Salting and Shipping. By I. D. Clarke. *Circ. No.* AIC-24, *U.S. Dep. Agric.* Pp. 9, $10\frac{1}{2} \times 8$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Mimeographed.

Replacements for Shoe Leather. By W. Gallay. *Canad. Chem.*, 1943, **27**, No. 10, 551-554. Describes the development of synthetic soleing compositions.

FORESTRY

General

Report of the Director of Forests, Queensland, for the year ended June 30, 1943. Pp. 4, 13×8. (Brisbane: Government Printer, 1943.)

Report on the Forestry Department, Gold Coast, for 1942-43. Pp. 5, $13 \times 8\frac{1}{4}$. (Accra: Publications Branch, Government Printing Department, 1943.) Price 1*s*.

Forest Research in India and Burma, 1941-42. Part 1. The Forest Research Institute. Pp. 151, $9\frac{1}{2} \times 6$. (Delhi: Manager of Publications, 1943.) Price R. 1 As. 4.

Annual Report of the Forest Department, Kenya Colony and Protectorate for 1942. Pp. 6, 13×8. (Nairobi, Kenya: Government Printer, 1943.)

Annual Report of the Forest Department, Mauritius, for 1942. Pp. 9, $9\frac{1}{2} \times 6$. (Port Louis: Government Printer, 1943.) Price 50 cents.

Annual Report of the Forestry Department, Nyasaland, for 1942. Pp. 15, $8 \times 6\frac{1}{2}$. (Zomba: Government Printer, 1943.) Price 1*s*.

Progress of Forest Entomology in South Africa. By F. G. C. Tooke. *J. S. Afr. For. Assoc.*, 1943, No. 10, 4-12. Describes the method of investigation of forest insect problems and control of the insects concerned.

Classification and Description of the Vegetation Types of the Niger Colony, French West Africa. By W. A. Fairbairn. *Pap. No.* 23, *Imp. For. Inst. Oxford.* Pp. 38, 10×6. (Oxford: Imperial Forestry Institute, 1943.) Price 4*s*.

Georgia Forest Resources and Industries. By A. R. Spillers and I. F. Eldredge. *Misc. Publ. No.* 501, *U.S. Dep. Agric.* Pp. 70, $10\frac{1}{2} \times 8$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 25 cents.

Louisiana Forest Resources and Industries. By R. K. Winters, G. B. Ward and I. F. Eldredge. *Misc. Publ. No.* 519, *U.S. Dep. Agric.* Pp. 44, $10\frac{1}{2} \times 8$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 25 cents.

The Soils and Ecology of the Wet Evergreen Forests of Ceylon. II. By R. A. De Rosayro. *Trop. Agric., Ceylon*, 1942, **98**, No. 3, 13-35.

Dutch Elm Disease and its Control. By J. M. Walter, C. May and C. W. Collins. *Circ. No.* 677, *U.S. Dep. Agric.* Pp. 12, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 10 cents.

The Proteins of Various Tree Seeds. By A. P. Lund and W. M. Sandstrom. *J. Agric. Res.*, 1943, **66**, No. 9, 349-355. Describes a study of the proteins of ironwood seed, elm seed and several varieties of acorns.

Timber

How to Identify Timbers. Part IV. Timbers for Boxes and Packing Cases. By S. S. Ghosh. *Indian For. Leafl. No.* 46 (*Utiliz.*) *For. Res. Inst.* Pp. 59, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1943.) Price As. 4.

How to Identify Timbers. Part V. Timbers for Gun and Rifle Parts. By K. Ahmad Chowdhury and K. N. Tandan. *Indian For. Leafl. No.* 50 (*Utiliz.*) *For. Res. Inst.* Pp. 5, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1943.) Price As. 4.

How to Identify Timbers. Part VI. Timbers for Camp Furniture. By K. Ahmad Chowdhury. *Indian For. Leafl. No.* 51 (*Utiliz.*) *For. Res. Inst.* Pp. 7, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1943.) Price As. 4.

Nomenclature of the South African Yellowwoods (*Podocarpus* spp.). By J. J. Kotze. *J. S. Afr. For. Assoc*, 1943, No. 10, 23-28.

Some West African Substitutes for Well-known Timbers. By M. H. Scott. *J. S. Afr. For. Assoc.*, 1943, No. 10, 29-39.

Deterioration of Fire-killed Douglas Fir. By J. W. Kimmey and R. L. Furniss. *Tech. Bull. No.* 851, *U.S. Dep. Agric.* Pp. 61, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 15 cents.

Studies on Adhesives. Part VI. Preliminary Note on the Use of Sunn Hemp Seed Proteins as Plywood Adhesives. By D. Narayanamurti, V. Ranganathan and D. C. Roy. *Indian For. Leafl. No.* 52 (*Utiliz.*) *For. Res. Inst.* Pp. 5, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1943.) Price As. 4.

Gums and Resins

La Explotación Resinera en los Pinares del Sudoeste de Francia. By P. Menendez Lees. Pp. 37, 9½ × 6½. Reprinted from *Rev. Fac. Agron. Univ. Montevideo*, 1942, No. 29. The exploitation of the resins of pine forests in South-West France.

Solvent Refining of Wood Rosin. By I. W. Humphrey. *Industr. Engng. Chem., Industr. Ed.*, 1943, **35**, No. 10, 1062-1067.

Tanning Materials

Natural Tanning Materials of the South Eastern United States. V. Domestic Dwarf Sumac. The Use of Leaves and Leaf Stems. By A. Russell and others. *J. Amer. Leath. Chem. Assoc.*, 1943, **38**, No. 10, 355-358.

U.S.A. Sumac as a Tanning Agent. By A. Russell and others. *Leath. Tr. Rev.*, 1943, **76**, No. 3011, 1474-1475.

Studies on Deterioration of Tanbark. By M. E. Fowler. *J. Amer. Leath. Chem. Ass.*, 1943, **38**, No. 11, 400-412. Gives details of tests of seven methods of curing bark.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 25

(October to December 1943)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

The Increase in Resistance in Insects to Insecticides. By H. J. Quayle. *J. Econ. Ent.*, 1943, **36**, No. 4, 493.

Pea Aphid Studies in Maryland. By L. P. Ditman, E. N. Cory, C. Graham and A. White. *Bull. A.*24, *Maryland Agric. Exp. Sta.*, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 20, 6080.) Compares the effects of derris, cube and nicotine.

Untersuchungen zur Biologie und Bekämpfung des Birnenknospenstechers (*Anthonomus pyri* Koll.). By H. Thiem. *Mitt. Biol. Reichsanst.*, 1941, No. 65, 40. (*R. A.E.*, 1943, **31**, A, Pt. 9, 371.) Sprays containing a mixture of derris and pyrethrum were effective against the pear blossom weevil in Germany.

Keine Gefährdung der Bienen bei Bestäubung der Rapsfelder mit Derris- und Pyrethrummitteln gegen Rapsglanzkäfer und Kohlschotenrüssler. *Z. Pfl Krankh.*, 1943, **53**, Pt. 1-3, 125-129. (*R. A.E.*, 1943, **31**, A, Pt. 9, 379.) No danger to bees through dusting rape fields with derris or pyrethrum.

Reduction of Flea Beetle Injury to Tomato Transplants by Treatment prior to Setting. By T. C. Watkins and S. H. Logan. *J. Econ. Ent.*, 1943, **36**, No. 4, 586-588. Derris and nicotine were among the products tested.

Results of 1942 Experiments for Control of the Mexican Bean Beetle at Fort Collins, Colo. By G. M. List. *J. Econ. Ent.*, 1943, **36**, No. 4, 624-625. Experiments were carried out with rotenone and pyrethrin sprays and dusts.

Undersökningar rörande föradsskadedjur. III. Svartbruna mjölbaggen *Tribolium destructor* Uytt. Ett nytt, ekonomiskt viktigt skadedjur. *Medd. Växtskyddsanst*, 1943, No. 40. (*R. A.E.*, 1943, **31**, A, Pt. 11, 438.) Household sprays of pyrethrum extract were effective against the larvae and adults of this pest of stored products; pyrethrum powder also satisfactory; derris dusts ineffective.

Glasshouse Thrips on Oranges in Coastal Districts. *Calif. Citrog.*, 1943, **28**, No. 6, 162. (*R. A.E.*, 1943, **31**, A, Pt. 10, 412.) Pyrethrum or nicotine added to summer oil spray gave good results.

Spraying and Dusting Potatoes. *Bull. No.* 319, *N. Dakota Agric. Exp. Sta.* (*R. A.E.*, 1943, **31**, A, Pt. 10, 435.) If aphids abundant they can be controlled by nicotine dust or spray; the addition of pyrethrum to copper dust mixtures protected from the attacks of leaf-eating insects.

Bordeaux and Other Sprays for Control of Japanese Beetle. By D. L. Collins and R. V. Nardy. *J. Econ. Ent.*, 1943, **36**, No. 4, 525-531. Derris powder and nicotine sulphate were among the products tested for protecting young elm trees.

The European Corn Borer (*Pyrausta nubilalis* Hubner) and its Control in Dahlias. By C. H. Batchelder, D. D. Questel and A. V. Cosenza. *U.S. Dep. Agric., Bur. Entomol.* E596, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4520.) Most satisfactory insecticides derris, cube or nicotine.

Weitere Untersuchungen zur Rapsglanzkafer-bekämpfung mit chemischen Mitteln. By E. Meyer. *Z. Pfl Krankh.*, 1943, **53**, Pt. 1-3, 62-73. (*R.A.E.*, 1943, **31**, A, Pt. 9, 378.) Derris and nicotine tested against *Meligethis aeneus* on rape.

The Control of the Chrysanthemum midge (*Diarthronomyia hypogaea* F. LW.). By G. G. Dustan. *Sci. Agric.*, 1943, **23**, 612-624. (*Amer. Chem. Absts.*, 1943, **37**, No. 19, 5821.) A spray containing lauryl thiocyanate was more effective than either nicotine or rotenone.

The Pistol Casebearer in Maryland. By H. S. McConnell. *Bull. No.* A-7, *Maryland Agric. Exp. Sta.*, 1942. Nicotine spray and derris are both effective in the pre-blossom period.

Ovicidal Properties of Certain Insecticides of Plant Origin. (Nicotine, Pyrethrins, Derris Products.) By C. Potter and F. Tattersfield. *Bull. Ento. Res.*, 1943, **34**, Pt. 3, 225-244.

Livestock Insect Control. A Study of Insects which attack Livestock and means for their practical control. By E. G. Thomssen and M. H. Doner. *Soap*, 1943, **19**, No. 11, 96-103. Dusts impregnated with pyrethrum and derris gave better protection against stable flies than spray.

The Insecticidal Outlook [in U.S.A.]. The possibilities of supply and requirements in 1944 for rotenone, pyrethrum, thiocyanates, arsenicals and other raw materials. *Soap*, 1943, **19**, No. 11, 107-110, 117.

Canadian War Record. Pyrethrum and Rotenone. *Canad. Chem.*, 1943, **27**, No. 10, 560.

Insecticide Stabilized Pyrethrum or Derris, etc. U.S. Pat. No. 2,168,064. *Brit. Chem. and Phys. Abstrs.*, B.III, 1943, 291.

The Action of Bean Leaves Against the Bed Bug. By H. H. Richardson. *J. Econ. Ent.*, 1943, **36**, No. 4, 543-545. Bean leaves are used in the Balkans for trapping bed bugs but the results of experiments indicate that they have no attractant action but act as traps by means of small hooked hairs present on both sides of the leaves.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Insecticidal Uses of Nicotine and Tobacco : a Condensed Summary of the Literature, 1690-1934. By N. E. McIndoo. *U.S. Dep. Agric., Bur. Entomol.*, E-597, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4524. Title only.)

Recent Tests with Some of the Newer Insecticides for Codling Moth Control. By D. W. Hamilton. *Proc. New York St. Hort. Soc.*, 1943, **88**, 152-158. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4520.) Experiments made with nicotine, xanthone and phenothiazine showed nicotine to be the most satisfactory.

O percevejo das orquídeas. By H. S. Lepage. *Biologico*, 1942, **8**, No. 3, 67-72. (*R.A.E.*, 1943, **31**, A, Pt. 10, 414.) Orchid bug (*Tenthecoris bicolor*) controlled by nicotine sulphate.

The Azalea White Fly in Australia. By R. T. M. Pescott. *J. Aust. Inst. Agric. Sci.*, 1943, **9**, No. 1, 29-30. (*R.A.E.*, 1943, **31**, A, Pt. 10, 421.) Satisfactory control was obtained with a white oil spray containing nicotine sulphate.

Recent Experiments in Insect Control in Nova Scotia. By A. D. Pickett. *Rep. No.* 79, *N.S. Fr. Grow. Assoc.*, 1942, 462. (*R.A.E.*, 1943, **31**, A, Pt. 11, 462.) Nicotine sulphate sprays proved effective against the bud-moth (*Spilnota ocellana*) and are recommended for dealing with the rosy apple aphis.

Cotton Aphid Damage and Control in Texas. By K. P. Ewing. *J. Econ. Ent.*, 1943, **36**, No. 4, 598-601. Describes tests with several compounds including nicotine sulphate.

The Citrus Pests Investigation in the Windward and Leeward Islands, British West Indies, 1937-1942. (*R.A.E.*, 1943, **31**, A, Pt. 11, 444.) Nicotine sulphate and soap spray used to prevent mites from spreading.

Control of the Holly Leaf Miner. By A. Hartzell, D. L. Collins and W. E. Blauvelt. *Contrib. Boyce Thompson Inst.*, 1943, **13**, 29-33. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 454.) Nicotine sulphate and fish oil spray produces good results.

The Present Status of Citrus-Thrips Control. By C. O. Persing, A. M. Boyce and C. S. Barnhart. *Citrus Leaves*, 1943, **23**, No. 3, 6-7. (*Amer. Chem. Absts.*, 1943, **37**, No. 18, 5542.) Nicotine sulphate and sugar gives good control on lemons.

Timing Applications for Control of Potato Aphids on Long Island. By W. A. Rawlins, R. W. Roth and J. E. Dewey. *Amer. Potato J.*, 1943, **20**, 184-189. (*Amer. Chem. Absts.*, 1943, **37**, No. 20, 6080.) Nicotine vapour and compounds tested.

Recovery of Nicotine from Impure Aqueous Solutions. U.S. Pat. 2,293,954. *Pharm. Absts., U.S.A.*, 1943, **9**, No. 10, 268.

The Cut Worm *Prodenia litura* Fabr. By R. J. A. W. Lever. *Agric. J. Fiji*, 1943, **14**, No. 1, 11-13. (*R.A.E.*, 1943, **31**, A, Pt. 9, 361.) Larvae killed by nicotine spray.

Neue Wege zur Bekämpfung des Baumweisslings. By O. Jancke. *NachrBl. Dtsch. PflSchDienst.*, 1942, **22**, 23-24. (*R.A.E.*, 1943, **31**, A, Pt. 9, 376.) Nicotine and tobacco extract tested against *Aporia crataegi* on plum trees.

Tobacco Aphid. *Rhod. Agric. J.*, 1943, **40**, No. 4, 213. Experiments carried out at the Trelawney Tobacco Research Station with commercial nicotine dusts against this pest showed the materials ineffective.

On the Biology and Control of Codling Moth (*Cydia pomonella* Linn.) in Baluchistan. By Nazeer Ahmed Janjua and C. K. Samuel. *Indian J. Agric. Sci.*, 1943, **13**, Pt. 2, 113, 128. Nicotine sulphate among the insecticides tested.

The Distribution of Nicotine Between Some Petroleum Solvents and Water. By H. O. Askew. *N.Z. J. Sci. Tech.*, 1942, **24**, No. 1B, 39B-41B.

Ann. Rep. Exp. Res. Sta., Cheshunt, 1942. Refers to the effect of immersion of eelworms in dilute nicotine solution (p. 49) and to the success of application of dusts containing nicotine for treating tomato seedlings attacked by the leaf miner *Phytomyxa soleni* Macq. (pp. 59-61.)

Growing Tobacco for Dipping Purposes. With Special Reference to the Resistant Blue Tick. By P. M. Bekker and P. Koch. *Frmg. S. Afr.*, 1943, **18**, No. 211, 755-758.

The Extraction of Nicotine from New Zealand Tobacco. By H. O. Askew. *N.Z. J. Sci. Tech.*, 1942, **24**, No. 1B, 41B-46B.

Nicotic Poisoning in Cattle. By J. Pybus. Case Record No. 1. *Vet. Rec.*, 1943, **55**, 243. Nicotine Poisoning in Cattle. By T. H. Jones and F. V. John. Case Record No. 2. *Vet. Rec.*, 1943, **55**, 243-244. (*Vet. Bull.*, 1943, **13**, No. 10, 372.)

Nornicotine in Commercial Nicotine Sulfate Solutions. By C. V. Bowen and W. F. Barthel. *J. Econ. Ent.*, 1943, **36**, No. 4, 627.

Insecticides. U.S. Pat. No. 2,286,636. *Pharm. Absts., U.S.A.*, 1943, **9**, No. 10, 257. Hard rubber dust and poisonous alkaloids such as nicotine used with an oil such as cottonseed.

Aerosol Insecticides. L. D. Goodhue and W. N. Sullivan. U.S. Pat. No. 2,306,434. *Soap*, 1943, **19**, No. 9, 115. A process for dispersing napthalene, orthodichlorobenzene or nicotine in aerosol form.

New Products in Uganda. *Public Ledger*, 1943, No. 33,283, 6. Nicotine being successfully produced.

Other Alkaloid-containing Materials

High-boiling Bases of *Anabasis aphylla*. By E. Späth, F. Galinovsky and M. Mayer. *Ber. Deuts. Chem. Ges.*, 1942, **75** (B), 805. (*Quart. J. Pharm.*, 1943, **16**, No. 3, 310.)

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

The Corn Earworm Infestation of 1942. By L. P. Ditman. *J. Econ. Ent.*, 1943, **36**, No. 4, 629-630. Experiments showed that on snap and lima beans rotenone-bearing dusts were ineffective.

Density and Particle Size of Derris and Cube Powders. By E. L. Gooden. *J. Econ. Ent.*, 1943, **36**, No. 4, 632-633.

Memorandum on the Control of Head Lice. *Mem. No.* 230A, *Minist. Health.* (*R.A.E.*, 1943, **31**, B, Pt. 10, 205-206.) Creams of derris or cube were efficient and rotenone powders effective.

Parlatoria chinensis Marlatt. By H. Baker and others. *U.S. Dep. Agric., Bur. Entomol.* E-595, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4521.) Addition of rotenone to oil sprays markedly increases the effectiveness of the sprays against infestations of this scale insect.

The Control of the Mexican Bean Beetle and the Corn Earworm on Beans. *Trans. Peninsula Hort. Soc.*, 1942, 54-57. (*R.A.E.*, 1943, **31**, A, Pt. 9, 365.) Rotenone dust most effective against *Epilachna varivestis* but ineffective against *Heliothis armigera*.

A Review of the Insecticidal Uses of Rotenone and Rotenoids from Derris, Lonchocarpus (Cube and Timbo), Tephrosia and Related Plants. V. Anoplura. By R. C. Roark. *U.S. Dep. Agric., Bur. Entomol.* E-598, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 19, 5822. Title only.)

The Eradication of Sheep Ticks, *Melophagus ovinus*, by one Dipping in Dilute Derris-Water or Cube-Water Dips. By N. G. Cobbett and C. E. Smith. *J. Amer. Vet. Med. Assoc.*, 1943, **103**, No. 796, 6-10. (*Exp. Sta. Rec.*, 1943, **89**, No. 5, 590.)

Effect of Change of Temperature on Relative Toxicity of Rotenone and Phenol. By W. A. Gersdorff. *J. Agric. Res.*, 1943, **67**, 65-80.

Effect of High-fat Diet on Chronic Toxicity of Derris and Rotenone [to Rats]. By A. M. Ambrose, F. De Eds and A. J. Cox. *J. Pharmacol.*, 1943, **78**, 90-92. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4437.)

Rotenone Production Plan Shaping Up. *Oil, Paint Drug Rep.*, 1943, **144**, No. 13, **3**, 46. Refers to the production programme of the Western Hemisphere.

Allow Rotenone Content Increase. *Soap*, 1943, **19**, No. 12, 153.

Insecticidal Composition. U.S. Pat. 2,283,275. *Pharm. Absts., U.S.A.* 1943, **9**, No. 10, 257. Walnut shell flour, rotenone and viscous non-volatile, non-drying oil.

Activated Insecticide. Canad. Pats. No. 412,588 and 412,589. *Soap*, 1943, **19**, No. 9, 115. Rotenone and rotenone-containing derris-type resins in combination with certain compounds.

Derris

Derris Suspension as a Sheep-Dipping Fluid. By L. Morrison and G. B. McLeod. *N.Z. J. Sci. Tech.*, 1941, **23**, No. 4A, 244A-254A.

Toxicity of Derris Root. *Soap*, 1943, **19**, No. 9, 115. Note only.

Ueber die Bekämpfung von Kohlerdflöhen auf der Oelfruchtwinterung. By O. Kaufman and W. Frey. *Mitt. Biol. Reichsanst.*, 1941, No. 65, 74. (*R.A.E.*, 1943, **31**, A, Pt. 9, 373.) Derris dust killed almost all the beetles in field experiments in Germany.

Zur Rapsglanzkäfer Bekämpfung mit chemischen Mitteln. By H. Blunck and E. Meyer. *Anz. Schädlingsk.*, 1941, **17**, 102-107. (*R.A.E.*, 1943, **31**, A, Pt. 9, 381.) Derris dusts proved effective against *Meligethes aeneus* on rape in Germany.

Report of the Department of Agriculture, Zanzibar, for 1942. Brief reference to the extension of area under derris, p. 6.

Scandenin—A Constituent of the Roots of *Derris scandens*. By E. P. Clark. *J. Org. Chem.*, 1943, **8**, 489-492. The roots of *D. scandens* (grown in Florida) do not contain rotenone, but lonchocarpic and robustic acids are present and a new non-rotenoid substance, scandenin, $C_{26}H_{26}O_6$.

Lonchocarpus

Some Derivatives of Lonchocarpic Acid. By H. A. Jones and H. L. Haller. *J. Org. Chem.*, 1943, **8**, 493-495.

Others

Existencia de rotenona en la *Verbascum thapsus*. By O. Fernandez and M. Lobete. *Farm. Nueva*, 1943, **8**, 129. (Abst. in *Ion, Madrid*, 1943, **3**, No. 22, 295.)

Factors affecting the Rotenone Content of Devil's Shoestring (*Tephrosia virginiana*). By A. F. Sievers, M. S. Lowman and G. A. Russell. *J. Econ. Ent.*, 1943, **36**, No. 4, 593-598.

Rotenone in Yam Bean (*Pachyrrhizus erosus*). By J. Norton. *J. Amer. Chem. Soc.*, 1943, **65**, 2259. By a combination of extraction, partition and chromatographic absorption, rotenone was isolated as a crystalline solvate with carbon tetrachloride to an extent of 0·15 per cent. of the seed.

PYRETHRIN-CONTAINING MATERIALS

Pyrethrum Analysis. Revision of the factor used in the mercury reduction method for determination of Pyrethrin I. By J. G. T. Graham and F. B. LaForge. *Soap*, 1943, **19**, No. 11, 111-113.

Biological Methods of Determining the Insecticidal Values of Pyrethrum Preparations (Particularly Extracts in Heavy Oil). By F. Tattersfield and C. Potter. *Ann. Appl. Biol.*, 1943, **30**, No. 3, 259-279.

A Film Technique for the Biological Evaluation of Pyrethrum-in-Oil Insecticides for Use Against Stored Product Insects in Warehouses. By E. A. Parkin and A. A. Green. *Ann. Appl. Biol.*, 1943, **30**, No. 3, 279-292.

Pyrethrin Methods. By N. W. Gillam. *Aust. Chem. Inst. J. and Proc.*, 1943, **9**, 262-270. (Abst. in *Soap*, 1943, **19**, No. 9, 107.)

Testing Aerosols against Houseflies. By E. R. McGovran, J. H. Fales and L. D. Goodhue. *Soap*, 1943, **19**, No. 9, 99-107. An aerosol solution consisting of pyrethrum extract, sesame oil and dichlorofluoromethane was used.

Practical Field Tests of Oils and Oils Containing other Insecticides for the Control of the Earworm in Southern California. By J. Wilcox. *J. Econ. Ent.*, 1943, **36**, No. 4, 554-557. Tests demonstrated that oil containing a small percentage of pyrethrins is superior to oil alone and also to oil containing dichloroethyl ether.

Ueber das Auftreten und die Bekämpfung des Kohlschotenrüsslers. By W. Frey. *Mitt. Biol. Reichsanst.*, 1941, No. 65, 75. (*R.A.E.*, 1943, **31**, A, Pt. 9, 373.) A pyrethrum dust gave excellent control of *Ceuthorrhynchus assimilis*.

Pyrethrum. By H. C. Arnold. *Rhod. Agric. J.*, 1943, **40**, No. 4, 218-222; 289-292. Cultivation of the plant and preparation of flowers for marketing.

Recommendations for Control of Caterpillars on Cabbage in the South [U.S.A.] under Present Wartime Conditions. By W. J. Reid, Junr. *U.S. Dep. Agric., Bur. Entomol.* E-591, 1943. (*Amer. Chem. Absts.*, 1943, **37**, No. 15, 4519.) Pyrethrum the only satisfactory substitute for rotenone for use on cabbage after the heads begin to form.

Cochroaches and Their Control. By M. H. Doner and E. G. Thomssen. *Soap*, 1943, **19**, No. 9, 94-97, 113. Doubt expressed as to whether pyrethrum will be as important a constituent of roach powders as in the past.

The Preparation of a Standard Pyrethrum Extract in Heavy Mineral Oil, with Observations on the Relative Toxicities of the Pyrethrins in Oil and Aqueous Media. By J. T. Martin. *Ann. Appl. Biol.*, 1943, **30**, No. 3, 293-300.

Pyrethrum in Australia. *Planters' Chron.*, 1943, **38**, No. 10, 196. Prisoners of war in Australia to grow the crop.

Chilian Pyrethrum. *Pharm. J.*, 1943, **151**, No. 4173, 159. Acreage and production figures given.

Pyrethrum Growing in French Morocco. *Chem. Tr. J.*, 1943, **118**, No. 2942, 343. Resumption of trials reported.

Pyrethrum Growing in India. *Public Ledger*, 1943, No. 33,277, 4. Brief note.

Pyrethrum. Big Increase in Kenya's Production. *Public Ledger*, 1943, No. 33,346, 1.

Kenya's Industrial Development. *Public Ledger*, 1943, No. 33,339, 1. Site for a pyrethrum extracting factory being found.

Pyrethrum. Price Guaranteed to Kenya Growers for 1944 Production: Government Purchase of Crop up to 1947. *Public Ledger*, 1943, No. 33,294, 1.

Kenyan Pyrethrum Seed for Russia. *Chem. Tr. J.*, 1943, **118**, No. 2941, 21.

Nyasaland to Grow Pyrethrum. *Public Ledger*, 1943, No. 33,358, 1.

Pyrethrum Growing in Portugal. *Public Ledger*, 1943, No. 33,285, 1.

Pyrethrum Control of Typhus and Relapsing Fever. *Med. Parasitol.*, 1942, **10**, No. 5-6, 582-583. (*R.A.E.*, 1943, **31**, B, Pt. 11, 228.)

On Agricultural Malaria and Its Control with special reference to South India. By P. F. Russell, F. W. Knipe and H. Rao Ramanatha. *Indian Med. Gaz.*, 1942, No. 12, 744-754. (*R.A.E.*, 1943, **31**, B, Pt. 11, 219.) Spraying with pyrethrum preparations gave promising results.

The Possibilities of Cattle Fly Sprays in India. By S. K. Sen. *Indian J. Vet. Sci.*, 1939, **9**, Pt. 4, 339-348. (*R.A.E.*, 1943, **31**, B, Pt. 9, 173-174.) Sprays containing pyrethrum proved effective.

Pyrethrins in Camomile. By V. S. Konovalov and M. G. Yosifova. *Soap*, 1943, **19**, No. 12, 159. (*Farmatsiya*, 1941, No. 5, 31-33.)

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

The Castor Bean Plant as a Source of Insecticide. By H. L. Haller and N. E. McIndoo. *J. Econ. Ent.*, 1943, **36**, No. 4, 638.

A essencia de inhamui, novo inséticida da flora brasileira. By A. A. De Souza Machado. *Bol. Minist. Agric., Brazil*, 1941, **30**, No. 5, 33-35. (*R.A.E.*, 1943, **31**, A, Pt. 12, 479.) The essential oil of *Nectandra oleophorum* possesses insecticidal properties.

MINERAL RESOURCES

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from Reports made to the Dominion, Indian and Colonial Governments

ILMENORUTILE FROM SIERRA LEONE

IN the course of prospecting for wolfram in the Tonkolili River valley during 1942, Mr. F. A. Cassidy, Inspector of Mines, Sierra Leone, discovered alluvial concentrations of a mineral resembling rutile and forwarded a sample of the concentrate to the Imperial Institute for further examination and report as to its commercial value. The principal constituent of the concentrate, however, proved to be ilmenorutile, and although this mineral appears to be of no economic value at present, it is felt that an account of its occurrence in Sierra Leone may be of interest, as this is probably the first record of ilmenorutile in West Africa. Mr. Cassidy has kindly supplied details of the mode of occurrence of the mineral in order to supplement the Imperial Institute investigation, which comprises a chemical analysis by Mr. L. C. Chadwick and a mineralogical examination by Mr. T. Deans, who also prepared this account.

Ilmenorutile takes its name from the Ilmen Mountains in the Urals where the specimens first described were obtained. It may be regarded as a member of the rutile group of minerals in which part of the titanium is replaced by columbium, tantalum and iron, and in which columbium preponderates over tantalum, the name strüverite being restricted to varieties in which tantalum preponderates. The nomenclature of this group of isomorphous minerals has, however, not been settled; W. T. Schaller (*U.S. Geol. Surv. Bull.* 509, 1912, p. 38) has proposed that ilmenorutile should be the name for the group and A. B. Edwards (*Proc. Australian Inst. Min. Met.* 1940, No. 120, p. 735) has put forward the name tantalo-rutile.

Recorded occurrences of these minerals in countries of the British Empire are few, perhaps because they are not particularly distinctive in appearance; they occur in Western Australia, where varieties with widely differing contents of tantalum and columbium have been described, and in the Union of South Africa, while strüverite from Malaya has been described in this BULLETIN (Vol. IX, 1911, p. 354). Unfortunately the name ilmenorutile has

frequently been applied quite erroneously, especially in French West Africa, to minerals intermediate in composition between ilmenite and rutile.

The ilmenorutile from Sierra Leone was found in the alluvium of streams near Sakasakala on the Tonkolili River some 110 miles E.N.E. of Freetown. These streams drain granite hills on the east side of the Tonkolili River, and to the west of that river lies a schist belt trending N.E.-S.W. in which important deposits of iron ore occur. A number of interesting minerals have previously been recorded in alluvial concentrates from this region, including columbite-tantalite, cassiterite, wulfenite and gold.

The main concentration of the ilmenorutile was found in the Dayikoro and Madondoneh streams, about $1\frac{1}{2}$ miles east of Numbara Hill, one of the main outcrops of the Tonkolili iron ores. It was found to persist in appreciable quantities in the Tonkolili River gravels down to a point where prospecting was stopped about 5 miles below its junction with the Madondoneh. Above the junction towards the head of the Tonkolili the amount found was greatly reduced and formed but a small proportion of the heavy mineral concentrates. Streams draining from the opposite side of the granite hills into the Mawura River were not examined, but it is likely that concentration in these would be heavy.

The Dayikoro and Madondoneh were sampled by pitting at a dozen points and it was found that the ilmenorutile was usually concentrated in a zone from 4 to 6 in. in thickness at the base of the gravel and resting on rotted granite, the total thickness of alluvium and soil varying between 2 ft. 3 in. and 5 ft. The stream flats range from 40 to 350 ft. in width. Panning trials gave values ranging from less than 1 lb. to a maximum of $15\frac{1}{2}$ lb. of ilmenorutile per cu. yd., with a mean value of about $5\frac{1}{2}$ lb. per cu. yd. A large proportion of the mineral is coarse, and it is accompanied by few other heavy minerals, a little black garnet and possibly some ilmenite being observed. It would appear that the ilmenorutile crystallised in intimate association with quartz, for several pieces of milky quartz containing well-formed crystals were found. The granite of the surrounding country is variable in type, but in general is coarse textured with biotite mica and very large felspars; along the streams it is completely kaolinised.

The sample examined at the Imperial Institute is well concentrated, containing only 2·3 per cent. of other minerals, principally quartz. The ilmenorutile is black, with metallic lustre, in grains up to 10 mm. in length and most frequently about 5 mm. in length. Crystal form is frequently apparent, sometimes prismatic and sometimes tabular, but no good crystals could be picked out. The streak is grey with a slight tinge of green, and the hardness is 6. Specific gravity determined on several grains varied from 4·69 to 4·80, with a mean value about 4·74. There is no good cleavage, but traces of a parting are sometimes evident. Magnetic suscepti-

bility is evident only in a strong electromagnetic field and is considerably less than that of ilmenite.

Optically the mineral is opaque except when crushed very fine, when it is brownish yellow. Pleochroism is strong, brownish yellow for rays parallel to the fast vibration direction, and dull bluish green with maximum absorption for rays parallel to the slow-vibration direction. Both refractive index and birefringence are very high. Unfortunately the transparent fragments are too small to allow of the determination of the optic sign.

A small quantity of clean grains of the ilmenorutile was selected for chemical analysis. Analytically the separation of titanium, columbium and tantalum is a difficult and rather lengthy process, and the carrying out of a full and detailed analysis was not considered justifiable under present circumstances, once the general composition had been established. The analysis shown below must therefore be regarded as approximate only. Minor constituents present include manganese, vanadium, and probably tin. For comparison an analysis of ilmenorutile from the type locality is also shown :

Analyses of Ilmenorutile

	I Tonkolili Sierra Leone. *Per cent.*	II Ilmen Mountains Russia. *Per cent.*
TiO_2	55·7	53·04
Nb_2O_5	22·6	21·73
Ta_2O_5	9·4	14·70
FeO	11·0	10·56
Total	98·7	100·03
Specific gravity	4·74	5·14

I. By L. C. Chadwick, Imperial Institute.
II. By G. T. Prior, *Mineralog. Mag.*, 1908-10, **15**, 87.

Hitherto ilmenorutile has not been utilised commercially, and it is not likely to be used as a source of either titanium or columbium, as these metals are more easily obtained from the simpler ores, ilmenite, rutile, and columbite. If in the future, however, some use is found for the mineral the working of the Tonkolili deposits might be considered, particularly if the district becomes more accessible by the opening up of a railway to the neighbouring iron ore deposits.

ABSTRACTS AND NOTES

Obituary.—C. B. Kingston.—The death of Dr. C. B. Kingston, the well-known mining engineer, at his Sussex home on December 30, 1943, robs us of yet one more old friend and valued adviser.

Charles Burrard Kingston, who was born in Montreal, Canada,

in 1867, started life with the object of becoming a doctor. He was educated at McGill University, where he graduated in mathematics in 1887, and subsequently obtained the degree of B.A. Sc. in mining engineering in 1892. After gaining his early experience in mining in the United States, he proceeded to work in Western Australia, then in Italy, and later in South Africa, where until 1926 he was mainly engaged upon gold mining on the Witwatersrand. He afterwards became consulting engineer to the Anglo-American Corporation, in which capacity he was actively associated with the development of the copper mines of Northern Rhodesia, and during the last 15 years of his life was consulting engineer to various gold mining interests in Southern Rhodesia.

The honorary degree of Doctor of Laws was conferred on Dr. Kingston by McGill University in 1930, and he was elected President of the Institution of Mining and Metallurgy in 1938.

Dr. Kingston had a wide experience of mining, especially gold mining, in many parts of the Empire, and was always willing to place his knowledge and experience at the service of the Mineral Resources Department, of whose Advisory and Consultative Committees on Precious Metals he had been a member for many years.

Geological Surveying in Northern Rhodesia.—The following details of the areas in Northern Rhodesia which have been mapped geologically and those which remain unmapped, kindly supplied by the British South Africa Company, came to hand too late for inclusion in the article on Geological Survey work in the Colonies published in the last issue of this BULLETIN (pp. 264-286).

The Company owns the mineral rights over a total area of some 221,000 sq. miles, and granted Exclusive Prospecting Licences over 201,000 sq. miles to concession companies which mapped a total of 154,000 sq. miles, leaving unmapped 47,000 sq. miles comprising the following areas: (1) three fairly extensive areas between Lakes Mweru and Tanganyika, believed to consist mainly of alluvium and unmineralised sedimentary rocks; (2) a large area of alluvium about Lake Bangweulu; (3) a large part of the Luangwa Valley, floored mainly by Karroo rocks, and unhealthy on account of sleeping-sickness; and (4) flats along the middle Kafue River and land adjoining the Barotse Native Reserve.

The area between the railway and the Zambezi River south of the 16° parallel, covering 17,000 sq. miles, which has not been granted to any concession company, also remains unmapped, together with 3,000 sq. miles in sundry other areas. In the North Charterland Exploration Company's area of 10,000 sq. miles, 2,000 sq. miles were mapped by the concession companies. The Barotse Native Reserve of 57,000 sq. miles constitutes the largest unmapped area. Thus altogether 54 per cent. of the total area of Northern Rhodesia has been mapped geologically, or 67 per cent. of the country if the Barotse Native Reserve is excluded.

The British South Africa Company has kindly presented a set of the regional geological maps of the concession areas (scale 10 miles to 1 in.) to the Imperial Institute Library.

Geological Work in Tanganyika.—The following summary report on the work of the Geological Division of the Department of Lands and Mines, Tanganyika, covering the field and laboratory work carried out during the years 1940-1943, has been received from the Officer-in-Charge, Geological Division, Dodoma.

The war period has been marked by a shortage of geological staff and by an increase in laboratory testing and investigatory work beyond the capacity of the existing personnel and equipment. It is satisfactory to record that steps are being taken to remedy both these deficiencies.

1940

Field Geology.—At the outbreak of war there were four geologists in the field and the geological work performed was largely of an economic nature. A mining geological study of the Iramba-Sekenke goldfield was made by one geologist, and large-scale mapping carried out on several of the more important mines. In the Lupa goldfield two geologists were engaged in bringing mine records fully up to date, in the course of which work about sixty properties were examined and described. One geologist carried out regional geological mapping of the Mwanza degree sheet, which adjoins the Musoma goldfield to the south. No definite indications of an extension of economically successful gold mineralisation into this sheet were revealed, though, since the work was mainly concerned with geological mapping, it cannot be said that the area was exhaustively prospected.

Water Supply.—One engineering geologist, with a boring staff of three drill foremen, was occupied in boring for deep seated supplies of water, and five boreholes were completed during the year. Towards the end of the year it was decided for reasons of expediency to transfer the water-boring section to the Tanganyika Railways and Ports Service. The Geological Survey thus lost what had been an integral part of its constitution since its inception in 1926.

Laboratory Section.—Work carried out in the laboratories was shared by one geologist and one metallurgist. Besides mineralogical, petrological and chemical work to supply information to the general public and to the geological field staff a considerable quantity of ore-dressing research was also performed, and this was mainly directed towards increased gold output, though base metal ores as well as non-metallics also received attention. Among metallurgical problems that were dealt with were (*a*) recovery of gold from cupriferous tailings, (*b*) beneficiation of auriferous and galeniferous concentrates produced for export, (*c*) investigation into the causes contributing towards formation of base amalgam in an amalgam

barrel treating auriferous and galeniferous concentrate. Work on non-metallics included recovery of graphite of crucible grade from low-grade graphite-schist.

1941

Field Geology.—During this year the field geological staff was reduced to a single geologist who was engaged in mining geological work in the examination of diamond prospects in the Shinyanga and Mwanza areas and gold properties in the Musoma goldfield. The rich diamond prospect at Mwadhui (Shinyanga district) was examined and detailed geological surveys made of the North Mara, Ikungu and Phoenix (Mrangi) gold mines. Some regional geological mapping was also carried out in the Kinesi-Buturi area, north of Musoma Bay.

Laboratory Section.—Besides the usual run of petrographical, mineralogical and geochemical work, a considerable measure of assistance was given to the new committee that had been formed to promote the utilisation of substitute articles and materials made or procured locally, and so save shipping space. Advice was tendered relating to limestone, pozzuolanas, kaolin, glass-making sand, foundry sand, iron ores and local iron castings. The metallurgist was principally occupied in giving assistance to workers of small properties in their ore-dressing and metallurgical problems. This officer normally spends about one quarter of his time touring the gold-mining field, and on such occasions carries with him a locally designed and constructed, portable, cyanide-plant testing kit with which routine tests of cyanide plants can be rapidly and accurately accomplished without recourse to the mine laboratories, which, even if they exist, are as often as not inadequately equipped. This kit was found to be of great service in locating faults in milling practice.

Publications.—For the duration of the war it was decided not to print any more maps and bulletins, save in exceptional circumstances, but to carry their preparation to the typescript stage so that they could be printed after the war. During the year the following papers were prepared:

Bulletin No. 17: "The Ore Microscopy of the Gold Lodes of Tanganyika."

Short Paper No. 24: "The Geology and Gold Deposits of the Ruvu River Area."

Short Paper No. 25: "Preliminary Report of the Sekenke-Iramba Goldfield."

Short Paper No. 26: "The Geology of Uzinza and the Country East and South of Mwanza."

1942

Field Geology.—The field geological staff was increased to two by the return of one officer who had been seconded to the military forces during the East African campaign. The nature of the geological work, which was entirely economic in character, reflected

the growing tendency as the war progressed for more attention to be given to base metals and non-metallics. Lease-lend aid from the United States of America and the growing difficulty experienced by the gold mines in procuring supplies and maintaining skilled staff both contributed towards the limitation of gold production, the peak period of which was in 1941.

Rapid geological surveys were made by one geologist of deposits of graphite, lepidolite, galena, coal, lignite and sulphur, and a new series of mineral resources reports started. The other geologist was occupied in the tinfields (*a*) in giving geological advice on a pitting programme carried out in connection with the government-controlled tungsten mine at Kibanda, (*b*) in geological reconnaissance in the Western Biharamulo district.

Laboratory Section.—The year 1942 was an extremely full one for the laboratory staff, who, besides carrying out numerous investigations in connection with the treatment of gold ores, also performed ore tests on non-metallics, notably graphite and sulphur-bearing sand.

Consultative work carried out for the East African Substitutes Committee increased considerably, and related to fireclay; abrasives; lime, cement and building materials; pigments, etc.

Publications.—Typescript reports were prepared upon local deposits or sources of graphite, lithium minerals, galena and sodium sulphate.

Bulletin 16, "The Mineral Resources of Tanganyika Territory," was fully revised and sent to the press for printing in limited edition, but had not appeared at the end of the year.

1943

Field Geology.—The principal work carried out was a study of the structure of the Ufipa Coalfields in Western Tanganyika to ascertain the quantity and quality of coal available. The seams were found to be thin and impersistent and to have a high ash content.

One geologist was occupied on geological and mineral reconnaissance in the Western Province. He made examinations of the Lugufu dolomitic limestone quarries and of the Uvinza brine springs, and also paid a visit to the Mpanda mine. His report on the last indicates that much better lead values are to be expected in the E.-W. shear than had been shown by the diamond drill cores.

For the remainder of the year this geologist carried out mineral reconnaissance in the Ufipa and South Kigoma areas.

The remaining two geologists were engaged principally in economic mineral reconnaissance in the Central Province in the general neighbourhood of main road and rail communications. Mineral Resources Pamphlets were prepared on individual deposits of corundum, magnesite, graphite, limestone, soapstone, asbestos.

Laboratory Section.—The further decline of gold production was

reflected in a notable reduction in the number of gold assays performed for the mining public, and in test work on gold ores and mill products. This was offset by greater interest shown in non-metallics, particularly graphite, and from tests made at Dodoma it would appear that a yield of from 5 to 10 per cent. of crucible-grade flake can be recovered by flotation from an average grade of Tanganyika graphite-schist. A final pronouncement on the quality of the flotation products is awaited from the Director of Sundry Materials, London. Base metals are also receiving more attention and a very full ore test was carried out on a bulk sample of argentiferous galena, which company enterprise proposes to mine and smelt in this country.

Work carried out on substitutes for imported articles increased and related principally to abrasives, foundry preparations, hydraulic limes, lime-pozzuolanas, and cements. In the case of the first of these the scope of the work attained the production stage, justifying the application of the descriptive term "utilisation branch" to the Dodoma laboratory organisation.

Another investigation carried out during the year related to the provision of raw materials for the manufacture of Sorel cement roofing. It was found that the mother liquor from salt crystallisation at a local up-country saltworks using brine springs was rich in magnesium chloride. This liquor had been allowed in the past to run to waste, but it has now been shown that it constitutes a satisfactory source of one of the essential raw materials for Sorel cement manufacture. The other constituent, magnesite, occurs both in Kenya and Tanganyika.

In the latter half of the year laboratory work carried out was chiefly concerned with the testing of economic minerals, including magnesite, talc, clays, limestones, asbestos, sulphur-sand, waters and brines. Complete analyses were made of various bearing-metal alloys and boiler scale. A considerable amount of experimental ceramic work was also accomplished. There was very little work on gold ores and mill products.

Hone Production.—The production of vitrified corundum hones of the "Scotch" type for sharpening the knives of native rubber tappers was organised on a commercial scale as a separate activity under the technological control of the Geological Division. A new building has been erected adjacent to the Geological Survey offices, and in this the hones are being manufactured from newly discovered sources of raw materials by a process worked out in the Dodoma laboratories. At the end of the year 7,351 hones had been made, while large stocks of fabricated "green" hones and of processed raw materials had been accumulated. Production will be greatly expanded during 1944.

Publications.—Bulletin 16, "The Mineral Resources of Tanganyika Territory" (Revised Edition), appeared in print towards the end of the year.

Production of Tungsten by Electrolysis.—The normal method of producing tungsten metal from its ores involves the preliminary production of tungstic oxide or sodium tungstate which is subsequently reduced to metal by means of carbon or hydrogen at a red heat. A new method of obtaining the metal from its ores by electrolysis was described by C. G. Fink and C. C. Ma in a paper presented to the Electrochemical Society in New York on October 14, 1943. The process involves the electrolysis of a bath composed of tungsten ore dissolved in fused alkali borates or phosphates and has been tested by experiment on tungsten ores obtained from many different sources. Concentrates of wolframite from China, Burma, Argentine and Peru, of scheelite from Idaho, ferberite from Colorado and Mexico, hübnerite from Nevada, and complex ores from Bolivia, have all been used with complete success, and without preliminary treatment.

The equipment used during the experiments consisted of a small furnace containing a graphite crucible tightly packed round with granular carbon. The cathode consisted of an iron rod suspended in the centre of the crucible, and six graphite anodes attached to a metal ring were arranged inside it. The crucible was heated by means of two graphite electrodes contained in the walls of the furnace.

After a good deal of experimental work, using a bath composed of sodium carbonate or mixed alkali carbonates, which gave poor results, it was found that the tungstic oxide content of the ores would dissolve in baths of either fused alkali borates or alkali phosphates. These baths proved to be good conductors of electricity, and tungsten metal was deposited as a fine to coarse crystalline powder on the cathode, at relatively high current efficiencies. The impurities present in the concentrate were either dissolved or remained in suspension or insoluble, and the greater part of the arsenic volatilized away. The tungsten obtained from either the borax or the mixed phosphates bath was thus free from harmful impurities.

The optimum temperature for the borax bath method was found to be 1,050° to 1,300° C., with a current density of 50 amp./dm.^{2} and a bath consisting of 1·5 parts of borax to 1 part of ore. By this method the best yield obtained amounted to 417 grm./kw. hr. of 99·6 per cent. metal.

The phosphate bath consisted of a mixture of sodium pyrophosphate and metaphosphate in a molar proportion of 7 : 3, and the maximum efficiency was obtained with 1 part of wolframite concentrate dissolved in 1·75 parts of the mixed phosphates. The bath temperature should be maintained at 1,000° to 1,300° C., with a current density of 50 amp./dm.^{2}. The best yield obtained by this method was 505 grms./kw. hr. of 99·7 per cent. metal.

The use of alkali borates or phosphates as the fused salt reagents renders the process distinct from any other known commercial method for the production of tungsten metal, and it is claimed that

by this method tungsten metal can be obtained directly and economically from any ore, whether of high or low grade, without the necessity of any preliminary treatment for the production of tungstic oxide.

Vermiculite in Enamels.—Consequent on the brief announcement in the Annual Report of the Imperial Institute for 1942 (page 29) that the Mineral Resources Department of this Institute had received inquiries on the subject of the proposed new use of the mineral vermiculite in vitreous and porcelain enamels, a certain amount of further interest in this particular application of vermiculite has been evinced. Some additional details of the process by which the mineral is utilised in this way may therefore be of interest.

These further details are abstracted from an anonymous article in *S. Afr. Engng. and Min. Journ.*, 1943, **54**, (2), p. 231, entitled "New Enamelling Process—Details of the Use of Vermiculite," which contains the essential gist of the South African patent (S.A. Patent No. 929, sealed on the 27th March, 1943) granted in respect of the process which was invented in Durban, Natal, and is being used there by the Union Enamel Co., Ltd. It is interesting to see that an earlier note in this same South African journal had also aroused widespread interest, inquiries about it having been received in South Africa from Great Britain and from the United States of America.

The process is claimed to be particularly suitable for producing improved enamelled articles such as name plates, signs and similar types of ware, but whilst coloured enamels were previously produced largely by the introduction of metallic oxides, the present method using processed vermiculite is stated to give finishes of metallic appearance resembling gold, brass, copper or bronze.

Means are provided in the proposed invention of introducing raw vermiculite into a furnace at a temperature usually between 1650° F. and 2000° F. but in no case exceeding 2300° F. After subsequent rapid cooling and grinding, the treated material is sieved to remove dust, after which it is applied to the ware to be treated prior to the final firing operation. Two ways of applying the vermiculite to the ware are provided. Firstly, it may be incorporated in the enamel mix together with the other normal ingredients, or secondly, it may be dusted or sprayed on to the wet enamel coating of the ware.

It is stated that it is the conversion of the water content of the vermiculite into steam during the heat treatment that causes the swelling out of the mineral and that the subsequent rapid cooling is responsible for rendering the granules produced both rubbery and durable.

Two methods of removing the unwanted dust produced during grinding are proposed. In the first of these, the method which is to be preferred, sieving may be carried out through screens of 25-

and 40-mesh gauge, after which the treated material is transferred to a 60-mesh screen, where the fine dust is removed by compressed air at about 60 lb. per sq. in. Alternatively, ordinary sieving with agitation may be applied in order to effect a similar result, but it is said to be not quite so satisfactory as the air-blowing method.

The types of enamels to which the treated vermiculite is applied may be of the vitreous or porcelain varieties produced by the standard methods of applying and firing the primary coat followed by applying and firing the basic colour. Vermiculite of the desired colour is then mixed with enamel and water until a density similar to that used in ordinary porcelain enamels is reached, after which, as stated, it is sprayed or otherwise applied to the wet under-coat of the porcelain or vitreous enamel. After drying in the normal manner, the dried surface is lightly rubbed either with the fingers or with a soft pad in order to expose the granulated vermiculite, and the ware is then given its final firing, any loose particles of the mineral appearing on the surface of the enamel being removed by light rubbing with fine emery paper or other abrasive.

As an alternative to this wet method, the ground, heat-treated and screened vermiculite may be applied in the dry, powdered form on to the last coating of porcelain enamel while still wet, after which the process is continued by the method already described.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

Eruptive Rocks. By S. James Shand, D.Sc., Ph.D., F.G.S. Second Edition. Pp. xvi + 444, 8½ × 5½. (London: Thomas Murby & Co.; New York: John Wiley & Sons, Inc., 1943.) Price 25*s*.

The first edition of this stimulating book was published seventeen years ago and was duly noticed in this Bulletin (1927, **25**, 354). The second edition retains most of the original text suitably revised and somewhat re-arranged, while the incorporation of additional material has increased the size of the book by more than 80 pages. A slightly bolder type has also been used in the set-up, thus enabling the text to be read more easily.

The first nine chapters deal with igneous rocks; their fixed and fugitive constituents; the temperature, pressure and freezing of the magma; the magma and its walls; compatible and incompatible phases; and eruptive rock complexes. Chapters 10 and 11 discuss the classification of eruptive rocks and set forth the author's well-known system of petrography based essentially on the "saturation principle." This is described in considerable detail in the following eight chapters, various symbols being introduced to represent the

rocks in question. Thus, for instance, the St. Austell granite is represented by the symbol XOpα(13), where X denotes that the rock is eucrystalline, O that it is oversaturated with regard to silica, p that it is peraluminous, *a* the character of the felspar (Or > An), and (13) its colour index or the percentage of heavy to light mineral present.

The author, for various reasons, has thought it advisable to omit the original chapter on eruptive ore deposits, so that the work now concludes with a comprehensive statement on meteorites, their chemistry, mineralogy, texture and classification. Unfortunately, the sub-title of the book has not been amended accordingly, and as a consequence it is now incorrect.

Throughout the work the author has prefixed each chapter with a pertinent and choice quotation taken from widely varying sources The quotation from Sir Walter Raleigh to the effect that "we have to be on our guard against dead and petrified knowledge bequeathed to us by former generations" seems to have formed the keynote of the present revision, which has been greatly benefited by the author's excellent library facilities at Columbia University. As a result, this work is now one of the best and most up-to-date English texts concerning eruptive rocks in general.

MAGNESIUM: ITS PRODUCTION AND USE. By Ernest V. Pannell, M.I.E.E., M.I.A.E. Pp. ix + 137, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1943.) Price 12*s*. 6*d*.

This little book is a welcome addition to the well-known series of Pitman technical treatises, and aims at giving a short practical account of magnesium and its alloys from the engineering and industrial viewpoint.

The work is divided into two parts, the first of which deals essentially with the pure metal and occupies 44 pages arranged in three chapters devoted to the general properties of magnesium, the various sources of its industrial raw materials, and the principal methods adopted for its commercial extraction. Part 2, on magnesim alloys, occupies the remaining six chapters of the text, and discusses in some 90 pages their variation in composition as well as their heat treatment, casting, working, corrosion and protection, and industrial applications.

The book is written in an attractive style and is illustrated by means of 45 figures, including flow-sheets and photographs of plant machinery.

Its appearance is most timely and it will no doubt enjoy a wide circulation, for many people must be exercising their minds with the problem of finding peace-time industrial uses for this metal, the war-time production of which has grown to such enormous proportions that the expected output of the United States alone in 1944 is put at 531 million lb.

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PLANT AND ANIMAL PRODUCTS

ARTICLES

AUSTRALIAN SCIENTIFIC RESEARCH LIAISON, LONDON

Papers from Australia No. 214

BACTERIOLOGICAL TESTS ON AGAR MADE FROM AUSTRALIAN SEAWEED[1]

By H. L. JENSEN,
Macleay Bacteriologist, Linnean Society of N.S.W.
Department of Bacteriology, University of Sydney, Australia

A SAMPLE of agar prepared from *Gracilaria confervoides* was received from W. Angliss & Co. Ltd., Sydney. The sample consisted of a light greyish, finely flaky to almost powdery substance which on boiling (2 per cent. solution) yielded a viscous fluid more difficult to filter than ordinary agar. On cooling, the liquid solidified at 47°-48° C.; the resultant gel was of a more elastic consistency than ordinary agar. Various types of bacteriological work (general, medical, and agricultural) were tried with this material in comparison with imported agar, powdered or fibrous, of Japanese origin.

A.—*Cultivation of various pure cultures.*

1. Ordinary nutrient agar (meat extract-peptone-broth 2 per cent. agar). Unless otherwise stated, slope cultures on 5 ml. of agar in test tubes, incubated at 37° C. Powdered agar, from May & Baker, was compared with the local product. In these, as well as the following tests, the inoculum consisted of one loopful of a young broth-culture or thin cell-suspension in sterile saline. The

[1] Published by arrangement with the Secretary, Australian Scientific Research Liaison.

Australian agar is in the following called "A," the imported control agar "I." Results:

Bact. coli. Abundant growth on both agars, no difference in type.

Ps. pyocyanea. Abundant growth on both agars, but pigment less intense on "A."

Bact. dysenteriae (4 strains, Shiga, Sonne, Flexner a and b). Growth good (Shiga) to very abundant (Sonne), in very young cultures, especially of Shiga, slightly stronger on "A," where the growth was also more diffuse than on "I."

Staph. aureus. Abundant growth on both agars, after three days' pigment somewhat paler on "A," otherwise no difference.

Str. pyogenes. Delicate growth on both agars, at first slightly better on "A," afterwards a little stronger on "I."

Corynebact. ovis (plate culture, 10 ml. agar + 10 per cent. horse-serum). Excellent growth on both agars, no difference in appearance.

Corynebact. fimi (28° C.). Good growth on both agars, appearance similar, yellow pigment equally intense on both.

Proteus OXK (28° C.). Good growth on both agars, seems more spreading and fuzzy on "A."

Actinomyces griseus and *Act. viridochromogenus* (plate culture, 10 ml. agar, 28° C.). Both organisms abundant growth on both agars; aerial mycelium of the former species appeared first on "A"; brown pigment of the latter equally intense on both agars.

2. Blood-agar. Plate-cultures on 10 ml. nutrient agar as (1) + 10 per cent. horse- or sheep-blood; incubated 24 h. 37° C.

N.B.—Owing to the high viscosity of the local agar, uniform distribution of the blood is more difficult than with the imported agar, and the higher setting-point makes it necessary to keep the local agar at a temperature of 50°-52° C. while adding the blood; all manipulations must therefore be very rapid in order to avoid spontaneous lysis. When successfully prepared, the medium with local agar is fully satisfactory, and its firm and elastic consistency makes streaking very convenient.

Str. pyogenes. Good growth on both agars; haemolysis excellent, if anything stronger and clearer on "A."

Str. pneumoniae. Good growth, haemolysis and green pigment on both agars, no clear difference.

Staph. aureus. Abundant growth without haemolysis on either agar.

Throat-swab. Abundant growth on mixed flora, equal appearance on both agars.

3. Yeast extract-glucose-agar (Glucose 1·0 per cent., $NaNO_3$ 0·05 per cent., K_2HPO_4 0·05 per cent., Mg_3O_4 0·02 per cent., $CaCO_3$ 0·2 per cent., yeast-decoction (1/10) 5 per cent., agar 2 per cent.). Slope cultures on 5 ml. agar, inc. 28°-30° C. Washed fibrous agar as control.

Rhizobium meliloti and *Rh. trifolii*. Good and typical growth on both agars, but more rapid and somewhat heavier on " A."

Acetobacter suboxydans. Good growth on both agars, somewhat more moist and spreading on " A."

Saccharomyces sp. Excellent growth on both agars.

Dematium pullulans, *Penicillium notatum*, and *Haplographium* sp. Abundant growth on both agars, no significant difference in appearances.

B.—*Biological tests for various impurities in the agar* (*washed fibrous agar as control*).

1. Available carbon-compounds were tested for by making a plate-count from soil on a medium containing only 0·1 per cent. $(NH_4)_2 SO_4$ and 0·1 per cent. K_2HPO_4 in addition to 2 per cent. agar. Incubated 6 days at 28°-30° C. Count of bacteria + actinomycetes, "A" + 6·3 mill. per gm., " I " + 4·1 mill. per gm.

All colonies, especially those of actinomycetes, were much bigger and more compact on "A", which is evidently richer in available organic impurities than " I."

2. Available nitrogen compounds were tested for on a medium containing 1·0 per cent. glucose, 0·1 per cent. K_2HPO_4, 0·02 per cent. $MgSO_4$, 2·0 per cent. agar, slope cultures on 5 ml. medium, incubated at 28°-30° C. Test organisms were *Aspergillus niger*, *Ps. pyocyanea*, 4 unidentified bacteria and 2 unidentified actinomycetes picked from the plates in the previous test. Saline suspension used as inoculum. Growth was in all cases feeble on " I," but varied from fair to quite heavy on " A " ; this difference was particularly striking in a few of the unidentified bacteria and actinomycetes. The local agar is clearly richer in available nitrogen than the imported. Nitrogen determinations by the kjeldahl method showed the following N-percentages (air-dry material) :

	Local.	Imported, powdered.	Imported, fibrous, washed.
(a)	0·47	0·19	0·10
(b)	0·51		

3. Growth-compounds. Various organisms were grown on slopes of 5 ml. agar of the following composition : mannite 0·1 per cent., asparagine 0·05 per cent., KNO_3 0·05 per cent., K_2HPO_4 0·1 per cent., NaCl 0·01 per cent., $MgSO_4$ 0·02 per cent., $CaCl_2$ 0·01 per cent., $FeCl_3$ trace, agar 2·0 per cent., *p*H 7·4. Washed fibrous agar was used as control, saline suspension as inoculum, incubated at 28°-30° C. Test-organisms were *Rhizobium meliloti*, *Rh. trifolii*, 4 unidentified bacteria and 2 unidentified actinomycetes isolated from soil (cf. D1). All organisms, but especially the two rhizobia, grew better on " A," which appears considerably richer in " accessory " growth factors.

C.—*Detection of Corynebacterium diphtheriae.*

Plates of modified Clauberg-medium (nutrient agar as A1, + 4 per cent. solution 1/100 of potassium tellurite, and 20 per cent.

glycerinated blood) were streaked with throat-swabs from 6 cases of diphtheria. One of these proved negative on both agars. The others showed after 24 hours at 37° C. a good growth of *Cor. diphtheriae* on both agars; the colonies were rather bigger on "A," but their character was similar (4 *gravis*, 1 probably *mitis*). Microscopic examination (toluidine-blue followed by acetic acid) showed equally typical granules on both agars. Tests with known strains of *gravis*- and *mitis*-type gave the same result: size of colonies a little bigger on "A," but type of colony and microscopic appearance of cells not significantly different on the two agars.

D.—*Plate-counts*.

1. Soil. Local agar compared with fibrous washed agar. Medium, mannite-asparagine-agar, as B3 incubated 28°-30° C. 7 days, 6 replicate plates. Counts of bacteria and actinomycetes, mean and standard error, millions per gm.:

Agar.	Bacteria.	Actinomycetes.	Total.
"A"	$7·5 \pm 1·40$	$3·5 \pm 0·32$	$11·0 \pm 0·55$
"I"	$9·2 \pm 0·46$	$4·5 \pm 0·34$	$13·7 \pm 0·45$

The numbers are significantly lower on "A," probably due to prominence of spreading bacterial colonies, which are normally suppressed on this medium, and were little in evidence on "I." A spore-forming rod isolated from one of these colonies showed rapid spreading on "A," but very little on "I."

A count of fungi in the same soil was made on glucose-ammonium sulphate—agar of *p*H 4·0. The following numbers, in thousands per gm. of soil, were found after 6 days: "A," $138 \pm 6·9$; "I," $150 \pm 13·1$. The difference is not significant, and the general appearance of the various colony-types was the same on both agars.

2. Milk. Local agar was compared with powdered agar, for counts on "yeastrel"—peptone-agar + 1 per cent. milk and 1·5 per cent. agar (the standard medium for routine bacteriological counts in milk). Plates of "A" had to be poured at 50° C., owing to the higher setting temperature instead of at 45° C., as prescribed for the standard technique. After incubating 2 days at 37° C., quadruplicate plates from dilution 1/10,000 (lower dilutions too crowded for counting) showed the following numbers of colonies per plate: "A," $115·5 \pm 16·3$; "I," $166·5 \pm 15·6$. Counting on "A" was very difficult owing to a much stronger development of spreading colonies on this medium than on "I." For examination of milk the local agar thus appears unsuitable, and would probably generally be so for isolation of bacteria by means of poured plates from habitats likely to contain a considerable number of spreading organisms.

E.—*Attempts made to improve the local agar by removing some of its impurities*.

A portion of agar was macerated at 30 (later 37)° C. in tap-water which was frequently changed by straining through gauze.

Rapid growth of bacteria took place, accompanied by evolution of gas and acids. After 8 days, when gas-formation had ceased, the agar was washed, dried at 98° C., and used for making up nutrient agar. On this medium the development of spreading colonies was much less prominent than on the untreated agar, and not much stronger than on imported (powdered) agar. The high viscosity of the local agar also appeared to have been somewhat reduced by the maceration, and the nitrogen content had gone down from 0·5 per cent. to 0·29 per cent., but the setting point had remained approximately 48° C. Growth of various bacteria on ordinary nutrient agar, haemolysis by *Str. pyogenes* on blood agar, and appearance of *Cor. diptheriae* on Clauberg-medium made with macerated agar were materially the same as on untreated or imported agar.

F.—*Supplementary tests.*

Another sample, representing another batch of agar, was used for making up various media. Growth and appearance of *Bact. dysenteriae*, *Staph. aureus* and *Str. pyogenes* on slopes of ordinary nutrient agar, of *Str. pneumoniae* on plates of blood-agar, and of *Cor. diphtheriae* (*gravis* and *mitis*) on Clauberg-medium were all practically the same as found on the first sample. The physical properties of the second sample were also the same.

Summary and Conclusions

For cultivation of micro-organisms in general the locally manufactured agar seems quite suitable. In comparison with Japanese agar it has the advantage of a remarkably tough and elastic structure which makes it very convenient for streaked plates. Its disadvantages, in decreasing order of importance, are the following:

1. Pronounced tendency to permit spreading growth of some bacteria, which renders its use difficult or even impossible for counting and isolation of bacteria from materials (e.g. milk) where such spreading organisms are likely to be present, especially by means of poured plates. On streaked plates the tendency to spreading can in some measure be counteracted by cautious drying of the plates before use.

2. Setting-point of the melted agar at 48° C., which makes the medium inconvenient for the isolation of heat-sensitive bacteria by means of poured plates and precludes its use for routine bacterial counts in milk, if the standard technique is to be strictly observed.

3. A typical although vigorous growth of some bacteria, e.g. the defective pigment-formation by *Ps. pyocyanea* and the "fuzzy" growth of several others on slopes—a point of some significance in the identification of bacteria.

4. High viscosity of melted agar, which makes the filtration, the pouring of plates and especially the mixing of blood-agar somewhat difficult. This property, as well as the tendency to spreading, can to some extent be remedied by further purification.

5. High content of available nutrients, probably including growth-compounds. This is a disadvantage only for specific purposes, such as nutritive studies or the isolation of nitrogen-fixing bacteria. In other cases it may be an actual advantage and may account for the remarkably good growth of the diptheria bacilli and the root-nodule bacteria of leguminous plants. For large-scale cultivation of the latter the local agar would seem very satisfactory.

Generally it appears that agar from Australian seaweed can, with proper purification, be obtained of a quality satisfactory for almost any bacteriological work, except perhaps for purposes where it is essential that the medium shall be cooled to 45° C. or less before setting. So far as can be judged from the two samples examined, the material in its present state of purity is useful for several, especially routine, purposes, but cannot without reservation be recommended for research purposes or for use under circumstances where development of spreading bacterial colonies is to be expected. For such uses the commercial product requires further purification which may be effected, for instance, by simple maceration in water; to facilitate this process and avoid loss of material, a somewhat less finely divided state than that of the two samples examined would be desirable.

I wish to thank Mr. R. C. Betty, M.Sc., for the nitrogen determinations, and Dr. Phyllis K. Anderson for help and advice on the tests with *Cor. diphtheriae*.

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XANTHORRHOEA RESIN [1]

Prepared by the Council for Scientific and Industrial Research, Australia

Grass trees, sometimes called "blackboys," especially in Western Australia, or yaccas, or yackas, are widely distributed throughout the Commonwealth of Australia. They are characterised by their bunches of grass-like leaves growing at the top of an elongated trunk like a palm. Grass trees are found only in Australia, and belong to the genus *Xanthorrhoea* which comprises a number of species of tree-like plants belonging to the Lily family. The trunks are surrounded by the old leaf bases in which the resin is deposited, being either yellow or red in colour, according to the particular species.

Numerous attempts have been made to utilise the various parts

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of *Xanthorrhoea*. Most of this work has been in connection with the resin, but other parts have received attention. The core contains a considerable amount of sugar. A cattle fodder has been prepared from it, and its use for the production of commercial alcohol, by fermentation, has been suggested. E. A. Mann [1] proposed the use of the core of *Xanthorrhoea preissii*. He obtained yields of alcohol up to 1·24 per cent. of the weight of the trunk by fermenting an aqueous extract of the core with yeast. The core of *X. preissii* was found to obtain 50 per cent. of carbohydrates, including 10 per cent. of reducing sugars, 16 per cent. of non-reducing sugars and 25 per cent. of other carbohydrates. Experiments on paper making from the core and leaves have been carried out. In one experiment was obtained a yield of 40·9 per cent. of dried pulp calculated on weight of core dried at 100° C. The pulp was of satisfactory quality, but difficult to bleach. The bulkiness of the material was a disadvantage on account of the large volume of liquor required to completely cover it in the digester. A test with *X. preissii* gave only 23 per cent. Some of the leaves also seem to have possibilities. The leaf-bases, which are at present thrown away, should be useful. They would not need a preliminary treatment before being placed in the digesters. Destructive distillation of the whole tree has been recommended [2]. It is said that more products can be thus obtained from blackboy than from the distillation of any other wood. A number of claims exist for various products obtained from *Xanthorrhoea*, namely, various gum resins, camphors, balsams. The core is said to yield a saccharine substance of a similar nature to maple sugar. It is the resin of *Xanthorrhoea*, however, that has received most attention.

Although no less than fourteen species of *Xanthorrhoea* (grass trees) have been recorded, the principal resin-yielding species are as follows:

(1) *X. hastilis* R.Br., of Eastern and South-eastern Australia.
(2) *X. arborea* R.Br., of New South Wales and Queensland.
(3) *X. australis* R.Br., New South Wales, Victoria and Tasmania.
(4) *X. tateana* F.M., of South Australia.
(5) *X. preissii* Endl., of South-western Australia.

The term "gum" as applied to grass tree resin is incorrect, for the resinous matter which cements the leaf bases together is in the nature of a true resin, and does not possess the characteristics of a gum. Grass tree resin is insoluble in water, but soluble in alcohol. A gum either dissolves in water or just swells in that medium and then subsequently dissolves. Gums are usually insoluble in alcohol. Grass tree resin is known vernacularly as yacka or yacca gum, gum accroides, acaroid resin, Botany Bay gum, blackboy gum, etc. The species *X. hastilis* yields a yellow resin, whilst all the others, such as *X. tateana*, etc., yield red resin.

Methods of Collection

Grass tree resin is usually obtained by separating the leaf bases and the resin from the core by breaking with an axe, and sieving the resin from the leaf debris. The resinous mass is disintegrated by means of a stout stick, and the woody portion removed by using a gentle breeze, created either by means of a draught of air or by utilising a blower. J. C. Earl [11], who had an opportunity of obtaining first-hand experience of the methods of collection in South Australia, from whence the greatest quantity is obtained, has given an excellent description of the procedure in operation at Kangaroo Island and other centres of South Australia :

"After a preliminary trimming to remove charred portions, if any, the leaf bases are cut away from the trunk with an axe, an operation which requires some skill. The depth of the cut is such that when the leaf bases and gum fall into the hessian covered framework placed to receive them they separate readily, and do not remain caked together in large masses. If the cut is made right to the core of the tree the leaf bases are cemented together into large cakes by the resin near the core, and pass into the waste heap when treated in the 'jigger.' Care is also taken to avoid too shallow strokes, or making a second cut, as this involves the production of the leaf bases in pieces so small that it is difficult to separate them from the resin.

"The mixture of leaf bases and gum having fallen into the receptable placed for the purpose, is transferred to the 'jigger,' which separates the gum into two grades and rejects most of the leaf bases and any large lumps of leaf bases caked together with gum. The 'jigger' consists essentially of an inclined sieve with two gratings, one vertically above the other, the upper one being of wire netting of about ½ in. to ¾ in. mesh, and the lower of finer perforated sheet metal. The sieve is given a lateral shaking motion while the material is being fed in through a hopper at the top. The leaf bases remaining with the coarse gum are separated by winnowing.

"It is customary, though unnecessary, to chop off the crown of leaves on the tree. The tree often recovers even when so treated and sprouts again.

"In cases where the leaves have not been removed, the trees seem little affected by the removal of the gum, as sufficient is left on the tree to act as a protective covering to the core. From such trees also numerous nodules of plastic gum are often to be observed exuding from the trunk in subsequent seasons. In many cases trees have been stripped for gum twice or even three times at intervals of several years."

The Harrison Steaming Process

The Harrison steaming process has been designed with a view to minimising losses of gum during collection. It has been used to some extent commercially. The following particulars of the process

for the extraction of the gum have been furnished by Mr. C. A. Bromfield, of Kingscote, K.I.: "The tree is lopped and trimmed, as for the 'jigger.' A cloth is spread on the ground around the tree and the gum and fibre is then chipped off vertically, bagged, and taken to the concentration plant. The mixed fibre and gum is placed on sieves in a vat heated by steam. The gum melts and runs into trays, and is afterwards run out into receptacles to cool. The residue left on the sieves is used for firing the boilers. Little foreign matter is found in the gum prepared by the Harrison process, and it saves fully a third more gum than the ordinary 'jigger' method, but the tree is destroyed when the Harrison process is used."

Availability of Resin

There are no recent figures for the availability of Xanthorrhoea resin. Apart from a little gum collecting carried out on limited areas of the mainland, the industry is confined to Kangaroo Island, South Australia, where *X. tateana* is exploited. It has been estimated by Earl that fully 150,000 tons of gum are available for collection, and that, by suitable conservation of the trees, a perpetual supply may be obtained. In the years 1927-28 and 1928-29, South Australia contributed 98 per cent. of the total quantity of grass tree resin exported from Australia, supplying 47,694 cwts. in 1927-28, and 54,159 cwts. in 1928-29. In 1939-40 South Australia supplied 2,096 tons and Western Australia 338 tons of resin. No figures are available for production in other states, but the amount would be very small.

At present the red resin is being used in Australian munitions laboratories and is being exported to Great Britain, India, America, and New Zealand.

Early this year 60 tons of resin was sent to Great Britain. Originally 500 tons a year was cabled for, but this has since been changed to 150 tons a year. The reasons for this alteration are not known. 70 tons has recently been sent to private merchants in Great Britain, and 90 tons to private merchants in U.S.A.

Very small quantities are being exported to India and New Zealand.

In April 150 tons of the red resin was sent to the Munitions Supply Laboratories, Melbourne. This was expected to last for two months. A further 500 tons has since been ordered.

Present value of the resin varies from £10 18*s*. 0*d*. to £13 9*s*. 0*d*. per ton.

Uses of Resin

At present the resin is being used in munitions work, in pyrotechnical compositions and as a high melting-point lacquer and varnish for metals.

Before the war considerable quantities of grass tree resin were used in New South Wales for the manufacture of certain proprietary stove polishes and floor stains.

The Imperial Institute [3] carried out a number of experiments with a view to utilising the resin as substitutes for shellac and rosin in the manufacture of lacquer for metals, of spirit varnishes for wood, and for sealing wax manufacture. The red and yellow resins were mixed with shellac and incorporated with turpentine and chalk to form sealing wax. The wax made from the red resin darkened and decomposed rather readily on heating; this resin could only be used for very inferior grades of sealing wax. The yellow resin gave a wax which showed much less tendency to darken on heating, and it is suggested that it might be used either alone or in a mixture with shellac. Mr. J. L. Strevens [4] in his comprehensive series of articles dealing with the technology of grass trees, furnishes the following information regarding the uses of grass tree resin:

"The various species of acaroid resin have been used to the greatest extent in Germany, where they have served to mix with higher-priced resins, such as Manilla, gamboge and shellac, in the manufacture of spirit varnishes for certain purposes, metal lacquers and wood stains. To a certain extent they have been used as resin substitutes for the manufacture of paper size, in perfumery and soap making, and to a very limited extent for enriching illuminating gas, in the tanning industry, and in pharmacy."

Professor Max Bottler mentions the use of red grass tree resin for the manufacture of coloured spirit varnishes preferable to those made by dissolving dragon's blood, gamboge and saffron in alcohol, as they do not bleach out on exposure to light. Such lacquers are stated to approach shellac lacquers in durability.

The red resin mixed with an alcoholic shellac solution is used as a gold lacquer for covering metal articles (brass and tinned), for bottle capsules, preserved meats and meat extract tins, and for wood. As acaroid resin solutions have the property of absorbing chemically active rays of light, they are used to paint over windows in photographic dark rooms. The finest grades of acaroid resin are utilised as shellac adulterants in the manufacture of dark sealing wax.

In order to produce a hard lacquer, it is advantageous to make a mixture of shellac and acaroid resin, and to add some softer resin, such as colophony (rosin) or thick Venetian turpentine, which also prevents cracking of the lacquer. An inferior non-chipping resin is obtained by adding a little copaiba balsam or castor oil to a concentrated alcoholic solution of acaroid resin. As a rule, ten parts of acaroid resin, with fifteen parts of spirit and the addition of twenty parts of softer resin, gives a good lacquer.

Grass tree resin spirit lacquers of high viscosity dry with a brilliant gloss, and have been used in Germany to mix with thick shellac lacquers as wood polishes and stains (dark red or yellow). Instead of softer resins or castor oil admixtures with such combined stains and polishes, small quantities of linseed oil fatty acids or camphor (natural and artificial) were added. A standard mixture

consisted of two parts of grass tree resin, three parts of 95 per cent. alcohol, and 5 per cent. of linseed oil fatty acids.

It is noteworthy that dilute solutions of the resin dry flat and can only be used for dull varnish preliminary coatings. *Per se*, acaroid resin varnishes and lacquers are devoid of elasticity and toughness; but in admixture with shellac the resulting film is both tough and elastic. For french-polishing a good mixture is three parts of shellac and one part of resin *vice* all shellac. It has been stated that acaroid resin is used in certain leather varnishes and in soap-making as a combined dye and perfume.

Strictly, grass tree resin is not a substitute for shellac, from which it differs essentially in character, although it will do work of the same general type, but far less efficaciously. It can only be classed as slightly superior to American or French resin, which is used to dilute high-grade shellac down to low-grade, and there has always been the drawback of its impure nature and necessity for purification of the lacquers and varnishes made from it, which has retarded its extended uses.

From investigations conducted at the Imperial Institute during the period 1915-1917 to determine the suitability of grass tree resin as a substitute for shellac or resin in the manufacture of metal lacquers and wood varnishes, it was found that lacquers prepared from the resin, *per se*, satisfactorily stood exposure in a dry atmosphere, were only fairly satisfactory in a moist atmosphere, and deteriorated rapidly when wet. These drawbacks were overcome when the resin was used in admixture with shellac. With wood varnishes the coat was less brilliant than that from rosin (colophony) varnish, but showed better resistance to wear.

Picric acid may be produced from the resin by oxidizing it with nitric acid. The yield of picric acid from the red resin has been found to vary from 5 to 50 per cent. However, it has been definitely shown that it is unremunerative to use grass tree resin as a source of raw material for the manufacture of picric acid as against phenol (carbolic acid) from coal tar.

The red and yellow resins were examined as possible dyestuffs by the Imperial Institute in 1916. From results obtained it was considered that the resins would be unable to compete successfully with the natural dyestuffs, such as fustic, already in use, or with synthetic yellow and brown dyes, with which better results were obtained at a lower cost.

Composition and Properties of the Resin

All work on the chemistry of the resin has shown it to be a very complicated substance, and very little is known as to the actual composition of the resins of any of the species. No research on the subject has been published for some years.

In 1915 the Imperial Institute conducted preliminary experiments with samples of yellow and red resin forwarded from Australia.

Both kinds contained woody impurities, the amount in the yellow resin being fairly large. The resins gave the following results on examination:

		Yellow.	Red.
Moisture (in vacuo at ordinary temperature)	*per cent.*	3·0	3·5
Ash	,,	1·3*	0·24
Matter insoluble in alcohol (chiefly woody matter)	,,	13-14	4
Matter insoluble in ether	,,	23	16
Melting point (determined on the powdered resin in a capillary tube)		97° C.	110° C.

* *Including some sand.*

Lauterer [5] states that he obtained 9·4 per cent. of benzoic acid from the resin of *X. hastilis* and 5·6 per cent. from that of *X. arborea*; whilst according to the *Perfumery and Essential Oil Record* [6] red acaroid resin has been found to contain 4·6 to 7·2 per cent. of benzoic acid. In view of these statements attempts were made to isolate this acid at the Imperial Institute. It was found, however, that in the case of the samples of both the yellow and red resins which were investigated, no appreciable quantity of benzoic was present.

According to Stenhouse [7] the resin on dry distillation yields an oil "which appears to be completely identical" with phenol. Attempts to distil the resin at the Imperial Institute were unsatisfactory, as the resin foamed very strongly and charred. Only small quantities of oily distillate were obtained. This possessed a phenol-like odour, but no definite indication of the presence of phenol was shown by the ferric chloride test.

A more detailed investigation was subsequently conducted with a commercial sample of red Xanthorrhoea resin which was subjected to a preliminary purification by extraction with alcohol in order to free it from about 12 per cent. of wood fibre and a small amount of mineral matter which it contained. The work carried out with this material was directed to the determination of (1) the approximate composition of the resin, (2) the effect of fusing the resin with potash, (3) the action of nitric acid on it, (4) the behaviour of the resin with oxidising agents (potassium permanganate, potassium dichromate and chromic acid), (5) the effect of heating the resin in sealed tubes, and (6) the products of its destructive distillation. Only a brief summary of the results obtained can be given here.

Composition.—The approximate composition of the resin purified by extraction with alcohol was as follows, as compared with the results obtained with red resin by Tschirch and Hildebrand [8]:

	Per cent.	Results obtained by Tschirch and Hildebrand. *Per cent.*
p-Coumaric acid in free state	0·5	1·0
p-Coumaric acid combined	1·5	2·0
Cinnamic acid	0·1	nil
Styracin	0·1	nil
Aldehydes	—*	*p*-Hydroxybenzaldehyde 0·6
Complex phenolic body	The residue	85·0

* *Not determined; probably vanillin is present in small quantity, as it was isolated after the oxidation of the resin.*

Results of Fusion of the Resin with Potash.—The following products were obtained after potash fusion of the resin compared with those obtained similarly from the yellow resin by Hlasiwetz and Barth [9].

	Per cent. (approximate).	Hlasiwetz and Barth from Yellow Xanthorrhoea resin. Per cent.
p-Oxybenzoic acid*	1·5	13·0
Resorcinol	2·0	1·4
Phenol	0·4	—
Pyrocatechin	not detected	1·8
A double compound of protocatechuic acid and *p*-oxybenzoic acid	not detected	2·3
Carbonic acid	much	—

* *It appears that the yield of this acid is dependent largely on the temperature of the fusion and the duration of heating. Earl ("Bull. No. 6, Dept. Chem. South Australia") obtained* 8 *per cent. of this acid from X. tateana resin, but, apparently, no resorcinol.*

Action of Nitric Acid on the Resin.—The products obtained by the action of nitric acid on the resin under different conditions were: picric acid, p-nitro-phenol, an amorphous nitro-compound, and oxalic acid.

Action of Oxidising Agents on the Resin.—The following products were obtained as the result of the action of oxidising agents on the resin :

(*a*) Potassium permanganate:
- Oxalic acid, about 40 per cent.
- Acetic acid, small amount.
- Carbonic acid, appreciable amount.
- Vanillin, about 0·2 per cent.

(*b*) Potassium dichromate and chromic acid:
- Principally an insoluble chromium compound.

Effect of Heating the Resin in Sealed Tubes.—The resin is only slightly affected at a temperature of 150° C., and at higher temperatures undergoes decomposition with the production of products similar to those obtained on destructive distillation.

Destructive Distillation of the Resin.—Small-scale experiments gave a yield of about 17 per cent. of an oily distillate of a phenolic nature. The experiments were difficult to carry out, owing to excessive frothing of the melted resin.

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NOTES

Obituary.—Dr. Ernest J. Parry. It is with great regret that we record the death of Dr. Ernest J. Parry, F.R.I.C., barrister-at-law, which took place on April 30 last at the age of 72.

After leaving school, Dr. Parry was for a short time employed in the laboratories of a firm of wholesale druggists, and then became a pupil of Sir Thomas Stevenson, who was Professor of Chemistry at Guy's Hospital, Scientific Adviser to the Home Office, and Public Analyst for the County of Surrey. Later, Dr. Parry joined the London County Council as an Assistant Chemist, when he specialised in the analysis of water. In 1896 he set up in practice as a consultant chemist.

Dr. Parry during his career carried out research work on a wide range of subjects, but he is best known for his studies on essential oils and shellac. Work on sandalwood oil in particular is always associated with him, and in this connection he visited Western Australia, where he was able to obtain first-hand information of this industry.

As an author Dr. Parry also made a name. He published a number of books either as sole author or in collaboration with others. Among his best known books are his *Chemistry of Essential Oils and Artificial Perfumes*, *Food and Drugs*, *Cyclopaedia of Perfumery*, *Shellac*, and (with J. H. Coste, his old colleague at the L.C.C.) *Chemistry of Pigments*. In addition he contributed considerable sections to Allen's *Commercial Organic Analysis* and to Thorpe's *Dictionary of Applied Chemistry*.

For very many years Dr. Parry rendered valued service to the

Imperial Institute as expert referee, and was ever ready and willing to give of his experience and knowledge. At the time of his death he was a member of the Institute's Consultative Committee on Gums and Resins.

Economic Conditions in West Africa.—In 1938 the Trustees of the Leverhulme Trust invited four members of Parliament to visit West Africa to study and report upon conditions there. The Commission, consisting of Col. Sandeman Allen, O.B.E., M.C., T.D., M.P., C. G. Ammon, M.P., E. Clement Davies, K.C., M.P., and Dr. L. Haden Guest, M.C., M.P., with E. P. Haslam, M.A., as Economic Adviser and Secretary, and accompanied by three other technical experts, spent about three months of the 1938-39 dry season in West Africa, some two months of which were devoted to a tour of Nigeria. In addition, visits were made to the Gold Coast, Sierra Leone, and the Gambia, and to parts of French West Africa. The outbreak of war interfered with the production of the various reports planned by the Commission, but it was decided to issue now the reports of the technical experts, which give a scientific survey of conditions in West Africa as they saw it in 1938-39, although it is recognised that many of the detailed observations are now out of date.

The reports now published privately by the Leverhulme Trust (Pp. 86, 1943) comprise I, "Crop Production and Soil Fertility Problems," by H. C. Sampson, B.Sc., C.I.E., lately of Kew, and E. M. Crowther, D.Sc., F.R.I.C., of Rothamsted, and II, "Live-stock Problems," by Lt.-Col. A. G. Doherty, M.C., M.R.C.V.S., of the Royal Zoological Society, Dublin. These are prefaced by a brief introduction by the Parliamentary Commissioners, who show a sympathetic understanding of West African circumstances. The West African economy is based mainly on subsistence farming; cash crops bring money which provides necessary but not first essential consumption goods, e.g. imported textiles, Birmingham ware and valuable supplements to local food production such as dried fish.

Mr. Sampson and Dr. Crowther decided to restrict the scope of their report, which occupies some fifty pages of the publication, to subjects on which they have special knowledge, viz., Crop Production and Soil Fertility Problems. It is only possible here to give the briefest outline of the very careful survey of these questions that the writers provide. The study begins with a description of geology, soils and climate, and continues with an account of crops and types of agriculture. The Departments of Agriculture are considered historically and in some detail, and there follows a discussion of the functions of other technical departments bearing on the questions under review and concerning co-operation with the Administrative Service. Some of their more important recommendations are contained in the concluding section which deals with scientific research and survey.

Lt.-Col. Doherty, in his report on Livestock Problems, covers roughly those aspects of such work which are the concern of the Veterinary Services. The cattle, sheep, goats, horses, other domestic animals and poultry of West Africa are described. In particular he has been able to emphasise the supreme importance of the cattle immunisation work that has been patiently carried on in the West African Dependencies by the Veterinary Services. A few notes embodying his views on game preservation are included.

These reports will provide the West African Governments and their technical officers with much that merits their consideration and attention. The first report in particular is an admirable and useful study, though there is perhaps some tendency towards easy criticism. The title of the second report may be a little misleading since it is confined, as already indicated, mainly to veterinary questions, and matters affecting animal husbandry (e.g. mixed farming) are considered in the first report.

As is recognised, resources available to the West African technical departments have been generally inadequate. There have been difficult years for these departments to contend with between 1918 and 1939, in particular the period of the world depression. Present tendencies hold promise of better things, and more provision for fundamental research on technical problems seems to be assured. The Commission's experts rightly stress the need for this, and the reports furnish many valuable suggestions of directions in which it might proceed. However, whatever the future organisation of scientific research in West Africa, it is to be hoped that no developments will be permitted in any way to weaken the position and influence of the technical departments upon whom progress will always depend and which will always need a full quota of specialist staff.

The reports are excellently printed, the paragraphs are numbered consecutively, and a useful index is provided. The publication contains many admirable illustrations.

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Processing Cottonseed Meal. A Manufacturing Method for Eliminating Toxic Qualities. By C. M. Lyman, B. R. Holland and F. Hale. *Industr. Engng. Chem., Industr. Ed.*, 1944, **36**, No. 2, 188-190.

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Oils and Oil Seeds

Report of the Ceylon Coconut Board for 1942. Pp. 11, $8\frac{1}{2} \times 5$. (Colombo: The Ceylon Coconut Board, 1943.)

Uma Experiencia de aplicação do Oleo de Andá-Assú. By A. Sacco Neto. *Rev. Quim. Industr., Brazil*, 1943, **12**, No. 139, 18-19. Trials with andá-assú oil (*Joannesia princeps*) as a drying oil in paints.

Fanweed Seed Oil. Potential Substitute for Rapeseed Oil. By J. R. Clopton and H. O. Triebold. *Industr. Engng. Chem., Industr. Ed.*, 1944, **36**, No. 3, 218-219. Gives particulars of the physical and chemical characteristics of the oil of *Thlapsi arvense* and discusses its possible industrial importance.

Economic Plants of Interest to the Americas. Oiticica and Chía Oils. By R. McVaugh. *Publ. U.S. Dep. Agric.* Pp. 13, $10\frac{1}{2} \times 8$. (Washington, D.C.: Division of Latin American Agriculture, 1943.) Mimeographed.

Sunflowers as an Oil Seed Crop. By G. E. Blackman. *J. Minist. Agric.*, 1944, **50**, No. 2, 517-521.

The Influence of Stratification of Tung-Seeds upon Emergence and Establishment of Seedlings in the Nursery. By Lai-Yung Li. *N.Z. J. Sci. Tech.*, 1943, **25**, No. 1, 43A-48A.

Observations and Experiments on Flowering and Pollination of the Tung Tree. By C. C. Webster. *E. Afr. Agric. J.*, 1944, **9**, No. 3, 136-143.

Two Mealy Bug Scale Insects on Tung. By G. Smee. *Nyasald. Agric. Quart. J.*, 1944, **4**, No. 1, 20-26. Study of methods of control of *Pseudococcus adonidum* and *P. perniciosus*.

Continuous Process for Solvent Extraction of Tung Oil. *Industr. Engng. Chem., Industr. Ed.*, 1944, **36**, No. 2, 138-144.

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Essential Oils

Australian Eucalyptus Oils, 1939-1943. By A. R. Penfold, F. R. Morrison and E. S. Guenther. *Soap Perf. Cosmetics*, 1944, **17**, No. 2, 116-117.

Oil of Lovage. By E. Guenther. *Spice Mill*, 1944, **67**, No. 3, 37-39. A survey of the cultivation of the plant, *Levisticum officinale* Koch, the distillation of the root, seed and herb, and the composition and properties of the oil obtained.

Production and Characteristics of Oil of Marjoram. By E. Guenther. *Food Industr.*, 1944, **16**, No. 2, 98-99, 136-137. Describes the cultivation of plants yielding oil of marjoram, the distillation of the oil and its properties.

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Some Fibers and Possibilities of their Development in the Western Hemisphere. By J. Z. Williams. *Cord Age*, 1943, **39**, No. 1, 8-10, 24; No. 2, 12-13; No. 3, 14-16; No. 4, 25-28; No. 5, 12, 28-30; No. 6, 26-27, 34. **40**, No. 1, 22-24; No. 2, 20-24, 26; No. 3, 24-26, 32; No. 4, 24-26, 31; No. 5, 24-26, 33.

Abacá—A New Crop for Latin America. By H. T. Edwards. *Agric. in Americas*, 1944, **4**, No. 1, 8-12. Describes the abacá fibre (*Musa textilis*) of the Philippines and the experimental plantings in Latin America.

Annual Report on the Technological Research Scheme, Indian Central Jute Committee, 1942-1943. Pp. 36, $9\frac{1}{4} \times 6\frac{1}{4}$. (Calcutta: Indian Central Jute Committee, 1943.)

The Genetics of (*Corchorus*) Jute. The Inheritance of Pod Shape and its Linkage Relationship. By L. M. Ghose. *Bull. Indian Cent. Jute Comm.*, 1943, **6**, No. 9, 366-369.

Economic Plants of Interest to the Americas. Kenaf (*Hibiscus cannabinus*

L.) as a Fiber Crop. By J. C. Crane. *Publ. U.S. Dep. Agric.* Pp. 39, 10½ × 8. (Washington, D.C.: Division of Latin American Agriculture, 1943.) Mimeographed.

Economic Plants of Interest to the Americas. Roselle (*Hibiscus sabdariffa* L.) as a Fiber Crop. By J. C. Crane. *Publ. U.S. Dep. Agric.* Pp. 47, 10½ × 8. (Washington, D.C.: Division of Latin American Agriculture, 1943.) Mimeographed.

Linen Flax Growing. By W. Stafford. *N.Z. J. Agric.*, 1944, **68**, No. 1, 31-36.

Technical Progress in Linen Manufacture. I. Recent Developments in Fibre Production. II. Modern Retting Practice. *Fairfax Mthly.*, 1944, **4**, No. 1, 15-18, No. 2, 45-46.

A Piassaveira e outras palmeiras Attaleaineas na Bahia. By G. Bondar. *Bol. No.* 13. Pp. 73, 9 × 6. (Bahia: Instituto Central de Fomento Economico da Bahia, 1942.) The piassava and other palms of *Attalea* spp. in Bahia.

Rubber

Report of the Work of the Rubber Research Board, Ceylon, in 1942. Pp. 46, 9½ × 6. (Colombo: Government Record Office, 1943.) Price Re. 1.

Fungicidal Control of South American Leaf Blight of Hevea Rubber Trees. By M. H. Langford. *Circ. No.* 686, *U.S. Dep. Agric.* Pp. 20, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 10 cents.

Contribution to the Morphology and Anatomy of the Russian Dandelion (*Taraxacum kok-saghyz*). By E. Artschwager and R. C. McGuire. *Tech. Bull. No.* 843, *U.S. Dep. Agric.* Pp. 24, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.)

A Spot Disease of Guayule (*Parthenium argentatum* Gray). By N. H. White and B. T. Dickson. *J. Coun. Sci. Industr. Res., Aust.*, 1943, **16**, No. 4, 258-260. Describes a foliage disease of guayule and its control by treating the seed with calcium hypochlorite.

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Classification and Grading of Flue-cured Tobacco Grown in Australia. By G. H. Marks. *J. Coun. Sci. Industr. Res. Aust.*, 1943, **16**, No. 4, 245-257.

Effect of Storage Conditions on the Viability of Tobacco Seed. By R. R. Kincaid. *J. Agric. Res.*, 1943, **67**, No. 10, 407-410.

Drugs

The Evaluation of Crude Drugs. By S. J. Hopkins. *Mfg. Chem.*, 1944, **15**, No. 3, 98-101.

Report of the Botanist, Department of Agriculture, Ceylon, on Visits to India and Java, 1938. Pp. 87, 9½ × 6. (Colombo: Government Record Office, 1943.) The visits described in this report were made with the object of studying the methods of cultivation and production of cinchona in these countries and of kapok in Java.

Experiments on the Growing of Mydriatic Drug Plants. By A. F. Sievers and M. S. Lowman. *J. Amer. Pharm. Assoc., Sci. Ed.*, 1944, **33**, No. 2, 45-56. Deals with belladonna, henbane and stramonium.

A Comparison of Some of the Ergot Alkaloids. Part 1. General Toxicology. By A. C. White. *Quart. J. Pharm.*, 1943, **16**, No. 4, 344-352.

Separation of Ergot from Rye Corn. By E. C. Plante and K. L. Sutherland. *Industr. Chem. Circ. No.* 4, *Coun. Sci. Industr. Res. Aust.* Pp. 11, 9½ × 6. (Melbourne: Government Printer, 1943.)

Ephedra Concentrate and the Extraction of Ephedrine. By T. P. Ghose

and S. Krishna. *J. Indian Chem. Soc., Industr. News Ed.*, 1943, **6**, Nos. 3 and 4, 142-147.

Hydnocarpus Oils in Ceylon, Part II. By R. Child and W. R. N. Nathaniel. *Trop. Agric., Ceylon*, 1943, **99**, No. 3, 140-142. Gives results of the examination of seeds of *Hydnocarpus anthelmintica* Pierre.

Cultivation of Papaw and Production of Papain. By F. R. Sanders and J. K. Robertson. *E. Afr. Agric. J.*, 1944, **9**, No. 3, 173-174.

Penicillin. By E. Chain and H. W. Florey. *Endeavour*, 1944, **3**, No. 9, 3-14.

Technique of Penicillin Products. *Mfg. Chem.*, 1944, **15**, No. 2, 51-52, 66.

La industria farmacéutica de la teobromina. By J. G. de Tánago. *Ion, Madrid*, 1943, **3**, No. 29, 743-751. The extraction of theobromine from cacao.

Livestock and Animal Products

Zebu-cross Cattle in Northern Australia. An Ecological Experiment. By R. B. Kelley. *Bull. No.* 172, *Coun. Sci. Industr. Res. Aust.* Pp. 96, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1943.)

Report of the Meat Commission, Union of South Africa. Pp. 39, $12\frac{1}{2} \times 8$. (Pretoria: Government Printer, 1943.) Price 2*s.* 6*d.*

Effect of Exercise on Quality of Beef. By S. Bull and H. P. Rusk. *Bull. No.* 488, *Illinois Agric. Exp. Sta.* Pp. 15, 9×6. (Urbana, Illinois: Agricultural Experiment Station, 1942.)

A Survey of the Dairy Industry in New Zealand. By W. M. Hamilton. *N.Z. J. Sci. Tech.*, 1942, **23**, No. 5A, 257A-283A; **24**, No. 1A, 1A-35A; No. 4A, 157A-185A; 1943, **24**, No. 5A, 223A-263A; No. 6A, 273A-302A.

Roughages for Dairy Cattle in Hawaii. By L. A. Henke. *Bull. No.* 92, *Hawaii Agric. Exp. Sta.* Pp. 29, 9×6. (Honolulu: Agricultural Experiment Station, 1943.)

Bacteriological and Practical Aspects of Paper Containers for Milk. By M. J. Prucha and P. H. Tracy. *Bull. No.* 495, *Illinois Agric. Exp. Sta.* Pp. 68, 9×6. (Urbana, Illinois: Agricultural Experiment Station, 1943.)

Effect of Pasteurization Times and Temperatures on Certain Properties and Constituents of Cream. By J. C. Hening and A. C. Dahlberg. *Tech. Bull. No.* 269, *N.Y. St. Agric. Exp. Sta.* Pp. 23, $8\frac{1}{2} \times 5\frac{1}{2}$. (Geneva, New York: Agricultural Experiment Station, 1943.)

Home Curing of Bacon and Hams. Compiled by the Small Pig Keepers' Council. *Bull. No.* 127, *Minist. Agric. Lond.* Pp. 57, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1943.) Price 1*s.* 3*d.*

The Dehydration of Pork. By J. A. Pearce. *Canad. J. Res.*, 1943, **21**, *Sec. D.*, No. 12, 394-404. Study of pre-processing and drying procedures for the dehydration of pork.

Scientific Principles of Poultry Feeding. By E. T. Halnan. *Bull. No.* 7, *Minist. Agric. Lond.* Pp. 60, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1944.) Price 1*s.*

Effect of Sulphur on Chick Nutrition. By R. M. Sherwood, J. R. Couch, L. James and C. W. Carter. *Bull. No.* 633, *Texas Agric. Exp. Sta.* Pp. 14, 9×6. (Texas: Agricultural Experiment Station, 1943.)

Poultry Costs and Profits. A Six-year Study of General Farm Flocks and Semi-commercial Flocks. By R. H. Wilcox and L. E. Card. *Bull. No.* 486, *Illinois Agric. Exp. Sta.* Pp. 32, 9×6. (Urbana, Illinois: Agricultural Experiment Station, 1942.)

Dried Egg. II. The Effect of Moisture Content on the Initial Quality of Spray-Dried Whole Egg and Deterioration During Storage. By J. R. Hawthorne. III. The Relation Between Water Content and Chemical Changes During Storage. By J. Brooks. *J. Soc. Chem. Ind., Lond.*, 1943, **62**, No. 9, 135-139.

Dried Egg. IV. Addition of Carbohydrates to Egg Pulp Before Drying. A Method of Retarding the Effects of Storage at High Temperatures and of

Improving the Aerating Power of Spray-Dried Egg. By J. Brooks and J. R. Hawthorne. *J. Soc. Chem. Ind., Lond.*, 1943, **62**, No. 10, 165-167.

Dried Egg. V. The *p*H of Reconstituted Dried Egg. By J. Brooks and J. R. Hawthorne. VI. The Water Relations of Dried Egg. By R. Gane. *J. Soc. Chem. Ind., Lond.*, 1943, **62**, No. 11, 181-187.

Dried Egg. VII. Methods for the Determination of the Solubility of Dried Whole Egg. By J. R. Hawthorne. *J. Soc. Chem. Ind., Lond.*, 1944, **63**, No. 1, 6-8.

Australian Fisheries Investigations. Some Conclusions Reached During the Quinquennium 1938-1943. By H. Thompson. *J. Coun. Sci. Industr. Res. Aust.*, 1943, **16**, No. 4, 279-286.

Techniques of Fishpond Management. By L. V. Compton. *Misc. Publ. No.* 528, *U.S. Dep. Agric.* Pp. 22, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.)

The Dehydration of Fish. Part I—General. By C. L. Cutting and G. A. Reay. *Chem. and Ind.*, 1944, No. 6, 47-50.

The Manufacture of Glandular Products in India. By B. B. Dey, P. S. Krishnan and M. Giriraj. *J. Sci. Industr. Res. India*, 1944, **2**, No. 2, 83-88.

Lanolin. By E. S. Lower. *Mfg. Chem.*, 1944, **15**, No. 1, 13-16, 35; No. 2, 68-71. Deals with the preparation, properties and uses of lanolin, giving details of its refinement.

Report on a Study and the Development of a Mold Resistant Treatment for Leather. By R. M. Lollar. *J. Amer. Leath. Chem. Assoc.*, 1944, **39**, No. 1, 12-24.

FORESTRY

General

Post-War Forest Policy Private Woodlands. Supplementary Report by H.M. Forestry Commissioners. Cmd. 6500. Pp. 11, 9½ × 6. (London: H.M. Stationery Office, 1944.) Price 2*d*.

Report of the Department of Mines and Resources, Canada, for the year ending March 31, 1943. Pp. 207, 9½ × 6½. (Ottawa: King's Printer, 1943.) Price 50 cents. Contains the Report of the Dominion Forest Service.

Report of the Department of Lands and Forests, Province of Nova Scotia, 1943. Pp. 103, 9½ × 6½. (Halifax, N.S.: King's Printer, 1944.)

Report of the Minister of Lands and Forests of the Province of Quebec for the year ended March 31, 1942. Pp. 146, 9½ × 6½. (Quebec: Government Printer, 1943.)

Annual Report of the Forest Department, Tanganyika Territory, for 1942. Pp. 8, 9¾ × 6½. (Dar es Salaam: Government Printer, 1943.) Price 50 cents.

The Position of Oak in British Forest Succession. By A. C. Forbes. *Emp. For. J.*, 1943, **22**, No. 2, 103-111.

Cork Forests in Tunisia. By N. A. Wylie. *Quart. J. For.*, 1944, **38**, No. 1, 10-14.

Timber

Effectiveness of Wood Preservatives in Preventing Attack by Termites. By T. E. Snyder and J. Zetek. *Circ. No.* 683, *U.S. Dep. Agric.* Pp. 24, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1943.) Price 10 cents.

Wood Tar as a Preservative for Timber. By W. P. K. Findlay. *Emp. For. J.*, 1943, **22**, No. 2, 151-153.

The Effect of Temperature on the Strength Properties of Wood, Plywood, and Glued Joints. By P. H. Sulzberger. *J. Coun. Sci. Industr. Res. Aust.*, 1943, **16**, No. 4, 263-265.

Resins

Annual Report of the Indian Lac Research Institute, India, for 1942-43. Pp. 39, 9½ × 7. (Nankum, Bihar: Indian Lac Research Institute, 1943.)

Agricultural Marketing in India. Report on the Marketing of Lac in India. *Marketing Ser. No.* 44. Pp. 213, 9½ × 6¼. (Delhi: Manager of Publications, 1943.) Price Re. 1 As. 4.

Tanning Materials

Economic Plants of Interest to the Americas. Wattle Bark. By F. J. Hermann. *Publ. U.S. Dep. Agric.* Pp. 10, 10½ × 8. (Washington, D.C.: Division of Latin American Agriculture, 1943.) Mimeographed.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 26

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

(January to March 1944)

GENERAL

Toxicity of Derris, Nicotine, and other Insecticides to Eggs of the Housefly and the Angoumois Grain Moth. By H. H. Richardson. *J. Econ. Ent.*, 1943, **36,** No. 5, 729-731.

An Outbreak of the Snipe Fly, *Symphoromyia hirta*. By H. B. Mills. *J. Econ. Ent.*, 1943, **36,** No. 5, 806. Some protection afforded by use of citronella oil; and tobacco smoke tended to discourage the flies hovering about the face.

The Action of Bituminous By-products and some Vegetable Poisons on Mosquito Larvae. By A. A. Shesterikova and A. A. Bushurova. *Med. Parasitol.*, 1942, **11,** No. 1-2, 23-24. (*R.A.E.*, 1944, **32,** B, Pt. 1, 2). Pyrethrum flowers, *Thermopsis lanceolata* and *Hyoscyamus niger* leaves and *Cicuta virosa* leaves and roots were tested.

Les *Antestia* spp. au Kivu. *Publ. No.* 26 *Inst. Étude Agron. Congo Belge, Sér, Sci.*, 1942. (*R.A.E.*, 1943, **31,** A, Pt. 12, 524.) Refers to the use of pyrethrum against this pest on coffee; pyrethrum more satisfactory than derris or Tephrosia.

Insect Pests of the Hop. By A. M. Massee. *J. Inst. Brew.*, 1943, **49,** No. 3, 136-139. (*R.A.E.*, 1944, **32,** A, Pt. 1, 15.) Nicotine spray gives control of *Forficula auricularia*; if derris unobtainable for controlling *Psylliodes attenuata* slaked lime can be used.

Life History and Control of the Tomato Pinworm. By J. C. Elmore and A. F. Howland. *Tech. Bull. No.* 841, *U.S. Dep. Agric.*, 1943. Rotenone, pyrethrum and nicotine were among various insecticides tested.

Insecticide Tests for Boll Weevil and Cotton Aphid Control in the Mississippi Delta. By R. L. McGarr and J. R. Henry. *J. Econ. Ent.*, 1943, **36,** No. 5, 716-718. Calcium arsenate treatment followed by a calcium

arsenate plus nicotine application gave satisfactory control; calcium arsenate plus rotenone not so satisfactory.

Eine bedeutsame Pflanzenschutzmassnahme im Erdbeeranbau. Der Erdbeerbluten und Stengelstecher. By W. Reimann. *Geisenheim Mitt. Obst. u. Gartenb.*, 1941, **56**, 113-114, 121-122. (*R.A.E.*, 1944, **32**, A, Pt. 2, 70.) Derris dust or mixture of derris and pyrethrum controlled the strawberry blossom weevil and stalk weevil.

Some Common Pests and Diseases in the Murray Irrigation Areas. By C. G. Grasby. *J. Dep. Agric. S. Aust.*, 1943, **47**, No. 4, 152-158. Refers to the use of derris and nicotine in the control of certain of the pests.

The Pea Aphid on Peas and Methods for its Control. By J. E. Dudley and T. E. Bronson. *Frms'. Bull. No.* 1945, *U.S. Dep. Agric.*, 1943. Rotenone and nicotine both give satisfactory control.

Insecticides and Forestry. *Chem. Tr. J.*, 1944, **114**, No. 2961, 164. Derris, pyrethrum and nicotine not very satisfactory against hairy caterpillars but proved effective against hairless varieties.

Reversals in Order of Effectiveness of Insecticides. By N. Turner. *J. Econ. Ent.*, 1943, **36**, No. 5, 725-728. Results of tests of dual-fixed nicotine dust and derris dust.

Agricultural Insecticides and Critical War Materials. By R. C. Roark. *J. Econ. Ent.*, 1943, **36**, No. 5, 720-724. Reviews the supply position of a number of preparations used in the manufacture of insecticides and includes references to several insecticides of vegetable origin.

Post War Planning. *Soap*, 1944, **20**, No. 1, 105-107, 133. Describes what South and Central America are doing to furnish the United States with rotenone insecticides; and the projected production of pyrethrum in South America.

Toxicity Studies on Insecticides. By H. A. Shelanski. *Soap*, 1944, **20**, No. 2, 107-109, 133.

Biological Control as a Supplement to Chemical Control of Insect Pests. By W. E. Ripper. *Nature*, 1944, **153**, No. 3885, 448.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Effect of *p*H on the Toxicity of Nicotine injected into the Cockroach, *Periplaneta americana*. By C. H. Richardson and L. O. Ellisor. *Iowa St. Coll. J. Sci.*, 1940, **14**, No. 3, 305-316. (*R.A.E.*, 1944, **32**, A, Pt. 2, 60.)

Ein Wickler als Gloxinienschädling. By H. Pape. *Z. PflKrankh.*, 1943, **53**, Pt. 4-7, 173-175. (*R.A.E.*, 1944, **32**, A, Pt. 2, 67.) Tobacco dust or nicotine spray would probably give control of *Cnephasia wahlbomiana*.

Zwei *Dasyneura*-Arten als Schädlinge der schwarzen Johannisbeere. By N. A. Vappula. *Ann. Ent. Fenn.*, 1941, **7**, 112-117. (*R.A.E.*, 1944, **32**, A, Pt. 2, 69.) Nicotine controls *D. tetensi* on black currants.

Die Douglasienwollans *Gilletteella cooleyi* Gill. und ihre Bekämpfung. By H. Muller. *Anz. Schädlingsk.*, 1941, **17**, 121-125. (*R.A.E.*, 1944, **32**, A, Pt. 2, 70.) Nicotine spray controlled the Douglas fir woolley aphis on nursery plants.

Grönsaksflyet angriper växthustomater. By E. Kjellander. *Växtskyddsnotiser*, 1943, No. 5, 15-16. (*R.A.E.*, 1944, **32**, A, Pt. 1, 19.) Nicotine fumigation failed to give control of *Polia oleracea* on greenhouse tomatoes.

Food-Crop Pests Investigation, Windward and Leeward Islands. First Report. Report on Working during the period April 1942-April 1943. By R. G. Fennah. (*R.A.E.*, 1944, **32**, A, Pt. 1, 22-25.) *Corythucha gossypii* and *Tetranychus* spp. on bean leaves controlled by nicotine sulphate spray; *Plutella maculipennis* and *Ascia monuste* on cabbage, cauliflower and watercress controlled by nicotine sulphate.

Studies on Nicotine Fumigation in Greenhouses. By H. H. Richardson, J. W. Bulger and others. *Circ. No.* 684, *U.S. Dep. Agric.* Chemical and

insecticidal tests were made with five methods of vaporising nicotine as a fumigant and on other factors affecting its efficiency.

La Chinche del arroz más conocida por "percevejo." Un insecto danino para el cultivo del arroz en la costa del Uruguay. By W. A. D'Angelo. *Alm. Minist. Agric. Argentine*, 1939, **14**, 43-46. (*R.A.E.*, 1943, **31**, A, Pt. 12, 475.) Nicotine sulphate spray effective against young nymphs of a rice bug on the banks of the Uruguay.

Cydia (*Laspeyresia*) *molesta* Busck. Su etologia y formas de lucha. By V. López Cristóbal. *Alm. Minist. Agric. Argentine*, 1939, **14**, 207-215. (*R.A.E.*, 1943, **31**, A, No. 12, 475.) Nicotine sulphate gave the most effective spray for dealing with this pest.

Frianite as an Insecticide Diluent. By E. R. de Ong. *J. Econ. Ent.*, 1943, **36**, No. 5, 799-800. An inert dust base developed by grinding and separation into grades which give varying rates of evolution of volatile insecticides such as nicotine.

Preliminary Studies on the Control of the Gladiolus Thrips (*Taeniothrips simplex*). By C. C. Hattingh. *Sci. Bull. No.* 221, *Dep. Agric. Un. S. Afr.*, 1940. Nicotine sulphate spray recommended. Gave better results than derris or pyrethrum.

Citrus Aphids. By J. H. Smith. *Queensld. Agric. J.*, 1943, **57**, Pt. 3, 162-163. Controlled by nicotine spray.

Warning About Nicotine Dressing. *Chem. and Drugg.*, 1944, **141**, No. 3335, 27. Dressing involves a certain risk to animals.

Other Alkaloid-Containing Materials

Toxicity of Anabasine to the Citrus Thrips. By E. A. McGregor. *J. Econ. Ent.*, 1943, **36**, No. 5, 805.

Piperine. The Toxicity of Solutions to Houseflies. By E. K. Harvill, A. Hartzell and J. Mc. Arthur. *Contrib. Boyce Thompson Inst.*, 1943, **13**, 87-91. (*Soap*, 1944, **20**, No. 2, 119.) Piperine, the alkaloid in the fruit of the black pepper and the amides of piperic acid toxic to houseflies.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Substitutes for Rotenone in Cattle Louse Control. By J. G. Matthysse and H. H. Schwardt. *J. Econ. Ent.*, 1943, **36**, No. 5, 718-720. Discusses the relative merits of ground sabadilla seed, nicotine, hellebore and pyrethrum as compared with rotenone.

The Effect of Certain Chemicals on the Cherry Fruit Fly. By R. G. Rosentiel. *J. Econ. Ent.*, 1943, **36**, No. 5, 800-801. Rotenone among the products tested.

Pea Aphid Control in Oregon. By K. W. Gray and J. Schuh. *Bull. No.* 389, *Oregon Agric. Exp. Sta.*, 1941. A dust containing rotenone and oil was the most efficient of the materials tested.

Water-soluble Preparations containing Rotenone for Pest Control. German Pat. No. 729,163. *Amer. Chem. Absts.*, 1944, **38**, No. 2, 452.

Insecticide Supply Outlook. Rotenone Supply Situation. By O. M. Poole. *Soap*, 1944, **20**, No. 1, 99-100.

Synthetic Insecticides. *Chem. Tr. J.*, 1944, **114**, No. 2936, 302. Refers to the use of indalone (a product made by the interaction of dibutyl oxalate and mesityl oxide) as a solvent for rotenone. Product itself is a repellant against biting flies and mosquitoes.

Derris

Die Bekämpfung des Rubenaaskäfers (*Blitophaga opaca* L.) mit Derris. By O. Kaufmann. *Anz. Schädlingsk.*, 1942, **18**, 53-56. (*R.A.E.*, 1944, **32**, A, Pt. 2, 70.) The control of *Silpha* (*Blitophaga*) *opaca* by derris.

Derris Culture in Puerto Rico. By R. H. Moore. *Circ. No.* 24, *Puerto Rico Exp. Sta.*, 1943. (*Exp. Sta. Rec.*, 1944, **90**, No. 2, 194.)

Achtet auf den Flachsblasenfuss ! Erfahrungen mit der Bekämpfung in Holland. By H. J. Wolters. *Dtsch. Landw. Pr.*, 1942, **69**, 202. (*R.A.E.*, 1944, **32**, A, Pt. 2, 68-69.) The best control of *Thrips lini* on flax in Holland was given by dusting with derris powder.

Derris Used for the Control of Head Lice and Pubic Lice. By H. L. Trembley. *J. Econ. Ent.*, 1943, **36**, No. 5, 795.

PYRETHRIN-CONTAINING MATERIALS

Stored Grain Pests and Their Control. By Hem Singh Pruthi and Mohan Singh. *Misc. Bull. No.* 57 (*2nd Revised Ed.*), *Imp. Coun. Agric. Res. India*, 1943. Thorough mixing of fine pyrethrum dusts with grain reported to give excellent results in protection from insects ; method not recommended because it is expensive.

A Most Simple Method for Destroying Mosquitoes (Phlebotomus) by Catching them with a Racket in Buildings of European Type. By E. N. Pavlovskii. *C.R. Acad. Sci. U.R.S.S.* (*N.S.*), 1942, **37**, No. 4, 150-152. (*R.A.E.*, 1943, **31**, B, Pt. 12, 236.) Dusting with pyrethrum powder or spraying with a fly spray of pyrethrum extract in kerosene recommended.

The Relative Resistance of *Periplaneta americana* and *Blatella germanica* to Pyrethrum Spray. By E. R. McGovran, J. H. Fales and P. Q. Piquett. *J. Econ. Ent.*, 1943, **36**, No. 5, 732-733.

Carpet Beetles. *J. Dep. Agric. Vict.*, 1943, **41**, Pt. 2, 555, 558. Spraying with pyrethrum-kerosene preparations recommended for control.

Cockroaches and an Effective Method of Trapping. By C. F. H. Jenkins. *J. Dep. Agric. W. Aust.*, 1943, **20**, No. 2, 110-112. Refers to value of pyrethrum spray for control.

Household Insects and Their Control. II. The House Ant. By Mohan Singh. *Indian Frmg.*, 1943, **4**, No. 5, 247-250. Kerosene pyrethrum sprays excellent for killing ants.

The Pyrethrins and the Role of Pyrethrum in Anti-Pest Measures. By T. F. West. *Chem. and Indust.*, 1944, No. 12, 110-111. Summary of a lecture given at the Society of Chemical Industry.

Pyrethrum for Aircraft. *Chem. and Drugg.*, 1944, **141**, No. 3338, 105. " Bomb," chief constituent of which is pyrethrum, being used for disinfecting aircraft.

Activated Pyrethrum Mosquito Spray. By E. R. McGovran and J. H. Fales. *Soap*, 1944, **20**, No. 2, 117, 119. Tests of iso-butyl-undecylenamide and sesame oil with pyrethrins.

The Beet Leafhopper and Its Control on Beets Grown for Seed in Arizona and New Mexico. By V. E. Romney. *Tech. Bull. No.* 855, *U.S. Dep. Agric.*, 1943. Experiments showed increases in seed yield when fields sprayed in the fall with pyrethrum-in-oil.

Dinitro Dust for Chinch Bugs. *Soap*, 1944, **20**, No. 2, 73. Pyrethrum was tested but found to be comparatively low in toxicity.

Cultivo del piretro dalmata de Erfurt. By Walther. *Die Pharm. Industrie* 1943, 162. (Abst. in *Ion, Madrid*, 1943, **3**, No. 27, 645-646 [in Spanish].)

Brazilian Pyrethrum. *Chem. Tr. J.*, 1944, **114**, No. 2955, 20. U.S. Government to purchase the whole of the crop.

Chile's Pyrethrum Output. *Public Ledger*, 1944, No. 33,407, 4.

Experiments with Arsenical and Non-arsenical Insecticides. By D. C. Mote and B. G. Thompson. *Proc. 6th Pacific Sci. Congr.*, 1939, **6**, 129-134. (*R.A.E.*, 1944, **32**, A, Pt. 2, 42.) Pyrethrum extract gave better control of *Diabrotica undecimpunctata* than calcium arsenate and other inorganic compounds.

Pyrethrum Species. *Proc. Lenin Acad. Agric. Sci. U.S.S.R.*, **6**, No. 10, 26-29. (*Soap*, 1944, **20**, No. 2, 73-74).

Pyrethrum Cultivation in Kenya. By R. S. Ball. *Nyasald. Agric. Quart. J.*, 1944, **4**, No. 1, 7-18. Issued by the Kenya Farmers' Association (Co-operative) Limited, Agents under the Pyrethrum Ordinance, 1935, Revised and Amended, 1943.

Insecticides Comprising Pyrethrum or its Active Ingredients together with Other Materials. U.S. Pat. No. 2,323,658. *Amer. Chem. Absts.*, 1944, **38**, No. 1, 211.

Pyrethrum Supply Outlook. By H. King. *Soap*, 1944, **20**, No. 1, 100.

Pyrethrum Synergists. Toxicity to Houseflies of certain N-Substituted Piperonylamides and Benzamides combined with Pyrethrins in Oil Base Insect Sprays. By W. A. Gersdorff and S. I. Gertler. *Soap*, 1944, **20**, No. 2, 123-125.

Stabilising Pyrethrum. Brit. Pat. No. 547,927. *Soap*, 1944, **20**, No. 2, 119.

U.S. Purchase of Pyrethrum. *Public Ledger*, 1944, No. 33,399, 1. To purchase Brazil's crop to be produced between October 1943 to December 1945.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Sweet-flag (*Acorus calamus*) in Mosquito Control. By L. A. Denisov. *Med. Parasitol*, 1942, **11**, No. 1-2, 97. (*R.A.E.*, 1944, **32**, B, Pt. 1, 7.)

Cashew Insecticide Spray. Canad. Pat. No. 414,715. A sprayable insecticide consisting of an emulsion of cashew nut-shell liquid, soap and water and may contain other ingredients. *Soap*, 1944, **20**, No. 2, 73.

Oalho no tratamento do berne. By J. R. Meyer. *Biológico*, 1943, **9**, No. 7, 163-168. (*R.A.E.*, 1944, **32**, B, Pt. 2, 23.) The use of garlic against larvae of *Dermatobia hominis*.

Amorphin, a glycoside in *Amorpha fruticosa* L. By F. Acree, M. Jacobson and H. L. Haller. *J. Org. Chem.*, 1943, **8**, 571-572. The seed of *A. fruticosa* gives the colour reaction in the Durham test which heretofore has been considered specific for rotenone and the rotenoids, but no compounds of this class could be isolated from them. The product responsible for the positive reaction in the Durham test is amorphigenin, $C_{22}H_{22}O_7$, the aglycon of the glycoside amorphin, $C_{33}H_{40}O_{16}$.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

SYNTHETIC RESINS AND ALLIED PLASTICS. By various authors. Edited by R. S. Morrell, M.A., Sc.D., Ph.D., F.R.I.C. Second Edition. Pp. xii + 580, $8\frac{1}{2} \times 5\frac{1}{2}$. (Oxford University Press; London: Humphrey Milford, 1943.) Price 35*s*.

In 1928, a textbook with the title "Natural and Synthetic Resins" was published under the joint authorship of T. Hedley Barry, A. A. Drummond and R. S. Morrell. The subject was later sub-divided by the publication of "Natural Resins" by Hedley Barry in 1932, and "Synthetic Resins and Allied Plastics," edited by R. S. Morrell in collaboration with T. Hedley Barry, R. P. L. Britton and H. M. Langton in 1937.

During the last few years the development and uses of synthetic resins and plastics has increased by leaps and bounds, and the

range of the subject has so widened that even four collaborators could not hope to deal with it adequately. Hence the plan has been adopted in this second edition, whereby the various sections of the subject have been written by a panel of nine experts under the editorship of Dr. Morrell.

The book, in its present form, consists of seventeen chapters, a subject index and an author index. The first chapter is introductory, chapters two to thirteen deal with the various types of synthetic resins and plastics. Chapter fourteen is devoted to electric testing and requirements for electrical work, followed by two chapters devoted to the problem of resinification. Finally, there is an important section on the methods of identification and testing of synthetic resins and other raw materials used in plastics.

This edition is very similar to the previous edition in format, but the subject matter has been considerably re-arranged and rewritten to compress into 580 pages a mass of useful information on a subject which has had a most important application during the war years and is likely to have an even more important future in the years of reconstruction which lie ahead.

SOLVENTS. By Thos. H. Durrans, D.Sc., F.R.I.C. Fifth Edition. Pp. xii + 202, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1944.) Price 17*s*. 6*d*.

The fact that another edition of this book has been called for in six years shows that it continues to prove of great value to those concerned with the manufacture of cellulose lacquers and solvents. The general arrangement of the book remains the same, but it has been revised throughout, and the section dealing with petroleum hydrocarbons has been rewritten. Those changes in the Solvent Industry due to war conditions which appear to be of a transient nature have been disregarded. The book is extremely well produced, considering the present-day conditions, and has been printed on thinner paper than the earlier editions. This, combined with the fact that it has been entirely reset, so as to economise space, gives it the appearancce of a smaller book, although, in fact, it contains more material than the last issue.

TEXTILE FIBER ATLAS. A Collection of Photomicrographs of Common Textile Fibers. By Werner Von Bergen and Walter Krauss. Pp. vi + 38, 12×9. (New York: American Wool Handbook Company, 1942.) Price $4.00.

This work is something more than the title suggests, since the plates are prefaced by a very useful account of the fibres, including their origin, microscopic characters, dimensions, etc., and, in the case of the animal fibres, their pigmentation. In the sections on wool particulars are also given of the United States Standards for grades of wool and of examination for fibre damage. Of the 25 plates of microphotographs, fourteen are devoted to animal hairs,

including wool, mohair, camel hair bristles, horse hair, human hair, cow hair, fur fibres, silks, etc. Six plates cover vegetable fibres—cotton, flax, hemp, jute, sisal, manila, New Zealand flax, piassava, raphia, coir and Spanish moss; four deal with artificial and synthetic fibres—rayons of different types, lanital, soybean fibre, nylon, etc.; and the last depicts mineral fibres—asbestos and glass. The photographs show the fibres in both the longitudinal view and in cross-section.

A bibliography embraces some 130 references to books and papers on the microscopy of fibres.

The atlas covers all important textile fibres, and should prove very useful to textile workers who have to identify the materials in question. War conditions prevented it being as comprehensive as was originally planned, but it has been published in loose-leaf form to enable supplementary plates to be added from time to time.

SUBSTITUTES. By H. Bennett. Pp. x + 225, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: The Chemical Publishing Co., Inc., 1943.) Price $4.00.

The aim of this work is to serve as a guide to materials which can be used to replace products which are in short supply, primarily owing to war conditions, and no attempt is made to describe them. Most of the materials are in the nature of substitutes, but in some instances lists of products are given which can be used as alternatives. Double columns are used giving the names of the products in alphabetical order on the left, and their substitutes or alternatives on the right. The names in the right-hand column also appear on the left, a method which enables still more substitutes to be located. For example, under Quince Seed, one finds as substitutes water-dispersible Gums and Psyllium seed, and under the latter name appear "Fijioline" and "Gomagel S 453." A preliminary section discusses in general terms the various conditions which determine the selection of substitutes.

The author does not claim the book to be complete or encyclopaedic, but rather a starting point from which the specialist can set out to solve his particular problem. It will have served its purpose if it simply draws attention to the possibilities of a material that might otherwise have been overlooked.

A DICTIONARY OF THE FUNGI. By G. C. Ainsworth, B.Sc., Ph.D., and G. R. Bisby, M.A., Ph.D. Pp. viii + 359, $7\frac{1}{4} \times 5$. (Kew, Surrey: The Imperial Mycological Institute, 1943.) Price 20s.

This reference book is compiled on the lines of Willis's *Dictionary of the Flowering Plants and Ferns*, which has for many years proved a boon to botanists and the scientifically-minded gardener. It brings together in one alphabetical list all words likely to be met with in mycological literature, including names of genera and families, descriptive terms, common names, etc. Under each

substantive generic name are given the author, systematic position, number of species and distribution, and in appropriate cases species of economic or pathological interest are mentioned. Outstanding structural or biological features are also given in many cases. Nomenclature has received special attention, and about one-half of the 7,800 generic names given are listed as synonyms. There are short accounts of the chief families, orders and classes, including references to the outstanding monographs on the group. G. W. Martin's key to the families of Fungi, from his *Outline of the Fungi* (1941) is printed as an Appendix. The definitions of the descriptive terms are brief and to the point, while 138 line drawings at the end of the book illustrate the wide variety of reproductive organs found in fungi and also many of the terms.

Altogether this is a most valuable compilation, and should be in the hands of all interested in the fungi, whether from the systematic point of view or in their interactions with human activities, as the causation of disease or the basis of important industries.

MINERAL RESOURCES

ABSTRACTS AND NOTES

Geological Survey Work in Canada.—In relation to the review of Geological Survey work in the Colonies which appeared in this BULLETIN last year (Vol. XLI, No. 4, October-December 1943, pp. 255-286) it is interesting to note that an informative paper on "Mapping by the Bureau of Geology and Topography" in Canada was read at the 1944 annual general meeting of the Canadian Institute of Mining and Metallurgy (*Canad. Min. Metall. Bull.* 1944, No. 383, 99-113). The portion dealing with Geological Survey mapping, contributed by G. Hanson, Chief Geologist, Canadian Geological Survey, is summarised in the following abstract.

The Dominion Geological Survey has mapped about 400,000 sq. miles (about 11 per cent. of the area of Canada) adequately for present purposes on scales of 4 miles or less to 1 in.; 10 per cent. on the 4-mile scale, and 1 per cent. on the 1-mile scale. Mapping by Provincial organisations has been mainly detailed work and does not increase the total by 1 per cent. It has thus taken 100 years to cover 11 per cent. of Canada, which indicates that the rate of progress is quite inadequate for the future. At present, however, the staff cannot even meet current demands for detailed investigations, and even by neglecting the less pressing of them, few men can be assigned to the systematic mapping of unmapped regions. Furthermore, as the expansion of the mineral industry will call for more and more detailed work by the Geological Survey, it appears unlikely that a staff of the present size will be able to increase the rate of progress in completing the mapping of the Dominion.

Topographical base maps are an important pre-requisite of geological mapping. By older methods a topographer could supply the waiting geologist with the base map of a 15-minute quadrangle in about one year, but now that aerial photography is first used, followed by ground work, the maps, although more accurate in detail, may not be available for two years. Provided a large area is mapped, however, the modern methods are both quicker and cheaper. In unsurveyed country, therefore, there is a considerable lag between the demand for geological work and its execution, and unless base maps of the country potentially valuable for mineral deposits can be prepared at a very greatly accelerated rate, systematically and at once, any attempt to speed up geological work will

be nullified. The vertical aerial photograph, however, is an excellent substitute for a map, and can be used as a temporary base map for geological work while the proper base is being prepared. Completion of the aerial photography of Canada would therefore provide temporary substitutes for maps of any part of the Dominion.

The scales hitherto adopted for mapping by the Geological Survey have been 1, 2, 4 or 8 miles to the inch, and 800 to 1,000 ft. to the inch for detailed work. The choice of the most appropriate scales for mapping will greatly affect the rate of progress. In making this choice it is necessary to consider the major geological regions of Canada individually.

The Canadian Shield is chiefly an area of granitic rocks enclosing older deformed complexes of altered volcanic and sedimentary rocks, which occur as belts of various sizes and shapes. It contains, here and there, basic intrusive bodies, and in some places late pre-Cambrian sedimentary and volcanic rocks that are less deformed than the older complexes. Many geologists consider that the Shield should be mapped on the 4-mile scale and that interesting areas should then be mapped in more detail. Experience indicates that the older complexes can be outlined with considerable accuracy by 4-mile mapping, but unless outcrops are abundant this scale is inadequate for interpreting the structure and stratigraphy of the complexes. It is not necessary, however, to traverse the country as thoroughly as is required in 4-mile mapping in order to find and outline these older complexes which form much the most promising areas for prospecting. Much greater speed can be obtained with approximately the same results by mapping on an 8-mile scale, and the author recommends that all the unmapped parts of the Shield should be mapped as quickly as possible on this scale. A group of three well-staffed geological parties, serviced by two aeroplanes and with radio communication, could probably cover about 45 one-degree quadrangles in a good season and complete the Shield in 20 to 25 years.

Except for the Shield, the remainder of Canada is underlain largely by sedimentary formations. Here, in contrast to the Shield, the areas of economic interest are not confined to isolated belts, and in fact all of this country may be interesting from an economic viewpoint. Although there are considerable areas of this type that geologists have never visited, our knowledge of the geology of such areas is appreciable because the type of geology permits the projection of formations for considerable distances into unknown areas. It is recommended that all the unmapped areas of this type should be covered as a first step by 4-mile mapping which will provide the necessary information for prospecting and other purposes. Many small areas so mapped will warrant more detailed mapping later.

Hanson makes the following suggestions in regard to the mapping of specific areas. In British Columbia and Yukon, 4-mile mapping

will satisfy most present requirements. In this mountainous region one geological party consisting of two working units will cover a one-degree quadrangle in 2½ to 3 years. On the Great Plains, outcrops are so scarce that 8-mile maps should suffice, but other factors, such as population, suggest that 4-mile maps should be issued. It would seem advisable here to supplement surface examination by core drilling to locate key horizons. One party of a single working unit can cover a one-degree quadrangle in a year. In the areas of flat-lying Palaeozoic rocks on the north, west and south fringes of the Shield, one party with two working units will probably complete a one-degree quadrangle in a year. Mapping of the iron belt south east of Ungava Bay should be started immediately on the 4-mile scale, with detailed studies at selected localities.

There remain certain areas where for various reasons future geological mapping should be on a 1-mile or larger scale. In the foothills of Alberta and British Columbia 1-mile mapping has been going on for some years and should be continued to completion, as it is the only adequate method of work in these complex areas. In the complex Grenville regions of the Canadian Shield in Ontario and Quebec only mapping on a 1-mile scale would be of use, but as this region is so extensive it is recommended that mapping should continue only in the well settled parts or where it is specially demanded.

The Eastern Townships and the Maritime Provinces, because of settlement, complexity in geology and diversified economic products, require 1-mile coverage of rather comprehensive type. In these places, the completeness of the work should approach that considered adequate around a city.

In conclusion, an estimate is made of the staff required and the rate of progress to be expected. Provided base maps are available, a staff of 60 geologists working entirely on 4- and 8-mile mapping will complete the unmapped regions of Canada in 20 to 25 years. At the same time, an additional 60 geologists will be required to work on 1-mile and detailed mapping to satisfy demand, and in 25 years they will probably cover half the ground now known to warrant such mapping. It is anticipated, however, that the 4- and 8-mile mapping will reveal so much favourable ground that 25 years hence the area warranting 1-mile coverage will be larger than at present. Such a programme will require a large increase in the staff of the Geological Survey, and the full complement of trained geologists may not be available until seven years after the war. The cost of this fully staffed Geological Survey would then be between 1 and 1½ million dollars a year. For a country whose mineral production has reached over 500 million dollars in a single year, the amount does not appear to be excessive, and the results will amply justify the expense.

Developments in the Canadian Magnesium Industry.—In spite of an abundance of magnesium-bearing rocks in Canada, no magnesium was produced from domestic raw materials until August 1942, when the first magnesium ingot was poured in the plant of the Dominion Magnesium Company at Haley's Station, Ontario, and by October 1943 this plant was reported to be producing the metal in excess of its rated capacity. During the world war of 1914-1918 there was a certain demand for magnesium for use in pyrotechnics, and, using imported magnesium chloride as raw material, the metal was produced successfully by an electrolytic process at Shawinigan Falls, Quebec. The demand ceased at the close of the war and the new industry was closed down.

A few years before the outbreak of the present war interest in magnesium metal revived, on account of its strength, lightness and alloying properties. Magnesium has a specific gravity of 1·73, which is two-thirds the weight of aluminium and a quarter that of steel; it forms light alloys comparable in strength with others which are much heavier, and this gives it importance as a constructional material for aircraft and other transport vehicles. The present wartime engineering outlets for magnesium alloys are now so numerous that it is certain that they will retain their usefulness in peace, and will probably find many new applications. The present satisfactory establishment of a magnesium producing industry in Canada is therefore of very great significance.

The first link in the chain of events which led to the establishment of the industry was forged in 1937 when the Director of the Canadian National Research Council assigned to Dr. L. M. Pidgeon the task of finding a means of producing magnesium metal from Canadian raw materials. Another important link was the work done by M. F. Goudge, Mineral Technologist, of the Division of Industrial Minerals, Bureau of Mines, Ottawa, in investigating the raw materials available in Canada. The results of his work, which were published in the *Transactions of the Canadian Institute of Mining and Metallurgy*, 1942, **45**, 191-207, are summarised below:

Brucite ($Mg(OH)_2$) occurs in Canada in the form of granules disseminated in crystalline limestone, the rock being termed brucitic limestone. The chief deposits of economic importance are to be found at Rutherglen, Ontario, and at Bryson and near Wakefield in Quebec. The reserves amount to many millions of tons, and the brucite is being used as the raw material for refractory products, for oxychloride cements, and is also suitable for the production of magnesium by electrolytic methods.

Magnesite ($MgCO_3$) occurs only in British Columbia and so far has not been developed. The largest deposit is near Marysville, and, although it contains a high percentage of impurities, suitable beneficiation and flotation processes have been worked out by the Consolidated Mining and Smelting Company of Canada, Ltd.; it

may be regarded as a potential source of magnesia and magnesium that may ultimately be developed.

Hydromagnesite ($4MgO.3CO_2.4H_2O$) occurs in British Columbia, and reserves amount to about 350,000 tons. It is not of present commercial importance.

Magnesitic Dolomite.—This is an unusual rock which occurs in Argenteuil County, Quebec, where it is being worked for the production of basic refractory materials by the International Magnesite Company, Ltd., and Canadian Refractories, Ltd. The reserves available amount to over 500,000 tons.

Dolomite ($MgCO_3.CaCO_3$) occurs in all the Canadian provinces except Prince Edward Island and Saskatchewan, and is particularly abundant in Ontario and Manitoba. It is used as a road metal, concrete aggregate, and for lime-making, as well as in pulp mills, agriculture and in glass production. Magnesia is recovered from dolomite by the Pattinson and other processes, and it is also an important source of magnesium metal. The Canadian deposits are fully described in the *Limestones of Canada*, by M. F. Goudge, published by the Bureau of Mines, Ottawa.

Magnesium Silicate Minerals include *serpentine*, which is abundant in Canada, particularly in Quebec, Ontario and British Columbia, and *olivine* ($2(Mg, Fe)O.SiO_2$), which occurs in the Similkameen and Tulameen districts of British Columbia, and as dunite near Vimy Ridge, Quebec. These are not being used as sources of magnesium at present, though suitable processes have been worked out in Canada and the United States, and they may be regarded as potential reserves. *Chrysotile asbestos* is also a magnesium, iron silicate, and the waste material from the asbestos mining industry promises to be a source of magnesium, the process having reached the pilot plant stage in the laboratories of the Dominion Bureau of Mines. The idea originated from H. G. Wildman, of Montreal, and the process involves crushing, leaching with hydrochloric acid, and subsequent concentration and recovery of pure anhydrous magnesium chloride by evaporation. Useful by-products are also obtained, and this process may prove to be of considerable importance. It is estimated that the daily production of tailings from the asbestos industry amounts roughly to 20,000 tons, and is sufficient to produce daily 3,000 tons of magnesium metal at relatively very low cost. More than 200,000,000 tons of waste are already available on the dumps.

Epsomite ($MgSO_4.7H_2O$).—Every autumn about 2,500,000 tons of epsomite are deposited on the bottom of Muskiki Lake about 45 miles north-east of Saskatoon, but are re-dissolved each spring. This is a potential source of magnesium chloride, with sodium as a possible by-product, but is not being exploited at present.

Brines, Bitterns and Sea-water.—Some carnallite has been found in the mine of the Malagash Salt Company at Michigan, but not in sufficient quantity for industrial operation. No other brines or

bitterns rich in magnesium chloride have yet been found in any quantity in Canada. Sea-water is an inexhaustible potential source of magnesium, but is not at present being used for this purpose in Canada.

Canada is thus well endowed with the raw materials for the production of magnesia and magnesium metal, but the full establishment of the industry depends also on the availability of power supplies, upon transport facilities and various geographic factors. Dr. L. M. Pidgeon, writing in the *Transactions of the Canadian Institute of Mining and Metallurgy*, 1944, **47**, 16-34, has described the factors which led to the choice of the thermic process of direct reduction of magnesia by silicon as the most suitable for the Canadian industry.

The two classes of process for the production of magnesium metal are (1) electrolytic and (2) thermic. In the electrolytic processes the ultimate cell feed is anhydrous magnesium chloride, and present practice varies only in the methods whereby this is produced. It may be obtained from any of the raw materials mentioned above. The main objections to the electrolytic method are: (*a*) the cell feed must be very pure; (*b*) handling of chlorine is often difficult and dangerous; (*c*) anhydrous magnesium chloride is difficult to produce and handle; (*d*) heavy electric currents must be generated.

The thermic processes depend on the direct reduction of magnesium oxide by means of carbon, calcium carbide, aluminium or silicon. The heat of formation of magnesium oxide is very high and the reaction is reversible; if, however, one of the products of the reduction is volatile and is constantly removed from the system the action will proceed in the desired direction despite unfavourable heat balance. Using carbon as the reducing agent both the products are volatile and shock-cooling methods must be resorted to in order to recover the metal. This method is being employed by companies operating in the United States, the United Kingdom, Australia, and Korea. With the other reducing agents mentioned the magnesium is the volatile product and must be constantly removed from the system. Calcium carbide is used by Murex, Ltd., in England and Australia. Aluminium is expensive, and with this reducing agent the reaction should proceed *in vacuo*. Aluminium-silicon or ferro-aluminium would be very suitable reducing agents.

Silicon is a useful reducing agent, which is readily available, being produced in the form of ferro-silicon in several Canadian plants. The action is strongly endothermic, but may be forced to proceed in the desired direction by removal of the magnesium formed at equilibrium. When magnesia is used as raw material, however, magnesium silicates are formed, thereby increasing the amount of magnesia required and reducing the yield of metal; thus: $3MgO + Si \rightarrow MgO.SiO_2 + 2Mg$; or $4MgO + Si \rightarrow 2MgO.SiO_2 + 2Mg$. When calcined dolomite is used in place of magnesia,

however, calcium silicate is formed and all the magnesium is recovered; thus: $2CaO + 2MgO + Si \rightarrow 2CaO.SiO_2 + 2Mg$, and this reaction forms the operational basis of the new Canadian magnesium industry now fully established.

The dolomite employed averages 21·88 per cent. MgO and 30·35 per cent. CaO. It is crushed and calcined to remove CO_2, the calcine being ground and mixed with ground ferro-silicon (75 per cent. Si), and pressed into briquettes. These are heated *in vacuo* to 1,100° C.—1,200° C. in horizontal retorts having removable condensers attached to their ends. The magnesium is deposited in these and can be removed for re-melting at the end of the reacting period.

The foundations of the new industry were established in the laboratories of the National Research Council between the years 1937 and 1939. In 1940 a pilot plant was set up at Ottawa, and this commenced operations early in 1941. The Department of Munitions and Supply then took over the project on an increased basis, and the Dominion Magnesium Company Ltd. was formed. In February 1942, the construction of a plant, designed for an output of 10 tons of metal daily, was begun at Haley's Station, near Renfrew, Ontario, the site being chosen on account of its proximity to large dolomite deposits. The first magnesium ingot was poured in this plant in August 1942, and full production was attained in February 1943; later in the same year the plant was reported to be producing in excess of the rated capacity.

In their *Preliminary Report on the Mineral Production of Canada*, the Dominion Bureau of Statistics estimates the production of magnesium metal in Canada in 1943 to have been 7,149,525 lb.

Chromite Deposits of the Eastern Townships, Quebec.—In peace-time Canada is not an important producer of chrome ore, her output having been only about 216,000 short tons since records began in 1886 until the end of 1943. The known deposits are either too small or too low grade to compete with other sources of supply in normal times, but during both the last war and the present conflict every effort has been made to locate and work domestic deposits in order to meet the exceptional war-time needs of chromite in Canadian manufactures and to reduce the necessity of bringing the ore for long distances over hazardous sea routes. During the last war and the two succeeding years the total Canadian output of high-grade chrome ore and concentrates amounted to 93,000 short tons, the record output being 24,000 short tons in 1917. Preliminary statistics indicate that the output for 1943 reached a new record of 30,085 short tons, an amount, however, which falls far short of domestic requirements. Most of the ore has hitherto come from the Eastern Townships of Quebec, especially the Coleraine district, and it was natural to return to this area for supplies when the necessity again arose. During 1940-42 about 85 chromite

deposits were examined by the Canadian Geological Survey in a belt about 100 miles long and 7 miles wide, and an account of recent developments in this area by C. H. Stockwell has lately appeared in *Canadian Mining and Metallurgical Bulletin*, February 1944, No. 382, pp. 71-86.

In south-eastern Quebec an irregular belt of serpentine extends for a distance of 470 miles from the Gaspé Peninsula to the Vermont boundary at Lake Memphremagog, and the chromite deposits occur mostly at the south-west end of this belt, though interesting discoveries have recently been made on the Gaspé Peninsula. The "serpentine belt" consists of partly or completely serpentinized dunite, peridotite and pyroxenite, the chief chromite deposits being confined to the dunite areas, though small grains of accessory chromite occur in all three classes of rocks, which were undoubtedly derived from a common magma.

The deposits of chrome ore may occur anywhere within the dunite masses, and there is no relationship between the size of the dunite body and its associated chrome deposits. The ore-bodies, which are usually elongate, are classified for purposes of description as tabular, lenticular and fracture-filling deposits, and in each of these the ore may be disseminated or massive. The tabular deposits are long in relation to their width and may extend to considerable depth. The chromite is usually disseminated in a serpentine groundmass, but there are all gradations from this to nearly massive ore. In some cases the deposits are banded, consisting of layers of chromite separated by layers of barren rock. Most of the ore that is mined comes from tabular deposits, though some of these are too small to be of economic value. By pinching and swelling along the strike the tabular deposits pass into lenticular deposits in which the ore occurs in lenses, pockets, or other irregular shapes, which may be deeper or shallower than they are long. They are difficult to mine, and frequently difficult to locate. In fracture-filling deposits, short irregular cracks in the dunite or spaces between fragments of breccia are filled with nearly massive or disseminated chrome ore. These deposits are very irregular and only one is workable.

The following is a brief summary of recent developments:

The Chromeraine Deposit.—This is a tabular deposit of low-grade, banded, disseminated chromite, lying at the west end of Caribou lake two miles south of the town of Black Lake. It is being developed by Wartime Metals Corporation, which is a Federal Government organization, and a mill of 600 tons daily capacity is in operation. The ore contains about 10 per cent. Cr_2O_3, and a concentrate of 48 per cent. Cr_2O_3 with a chromium to iron ratio of 2·4 : 1 is being produced.

The Sterrett Mine.—This mine is located at St. Cyr, and is operated by Chromite, Ltd. It is a lenticular deposit of disseminated chromite, which is not banded but which contains some massive

ore. The ore averages 18 to 28 per cent. Cr_2O_3, and the concentrate produced, in a mill of 150 tons daily capacity, averages 48 per cent. Cr_2O_3 and has a chromium to iron ratio of 2·7 : 1.

The Sterrett and Chromeraine mines are the most important chrome mines of this area, and were both worked during the last war.

Webster Lake Area.—In this area, which is four miles long and a mile wide, eighteen small deposits of good-quality ore have recently been found and mined, and many others of no economic value have been located. At one of the eighteen deposits, known as the Orford No. 4 Mine, the ore occurs in pockets or pod-shaped bodies, and consists of disseminated or massive ore. It was worked from July to November 1942 by the Orford Mining Company, financed by the government, but the work ceased as it became unprofitable. The other deposits of the area are small, and have been worked in open pits, the ore being hand-sorted.

The Montreal Pit.—During the last war this pit yielded 25,500 tons of 36 per cent. ore. During the present war operations have been carried on by Orel Paré of Black Lake, who has shipped ore to the Electro-Metallurgical Company, Welland, Ontario. An average sample gave a Cr_2O_3 percentage of 47·57, and a chromium to iron ratio of 2·44 : 1. The ore occurs in lenses, and is mostly in the form of disseminated chromite.

Caribou Deposit.—This was explored by the Asbestos Corporation during 1942, and 25,000 tons of ore, a sample of which contained 43·2 per cent Cr_2O_3 with a chromium to iron ratio of 2·8 : 1, have been indicated beneath the old underground workings. So far mining operations have not been started. It is the largest of the lenticular deposits, consisting of lenses distributed over a length of 1,200 ft., across widths up to 170 ft., and down to 400 ft. measured along the dip.

Provençal Deposit.—Some new lenses of chromite ore were discovered during 1942 in this area, near some old workings, but mining operations have not yet begun. The property is near the Chromeraine mill and belongs to the Wartime Metals Corporation. Present operations indicate 134 tons of 28 per cent. ore per foot of depth. A concentrate of 51 per cent. Cr_2O_3 and with a chromium to iron ratio of 2·68 : 1 has been obtained.

The Bergeron, Croteau, Greenshields and Greenshields Extension Deposits.—These deposits occur in a narrow zone 860 ft. long, not far from the Chromeraine mill on ground belonging to the Asbestos Corporation. No work is being done at present on the Greenshields pit. The Greenshields Extension was uncovered in 1942, and may be of some interest. The Croteau pit was worked during 1941, and a little ore was recovered. The Bergeron deposit was discovered in 1941, and has not yet been fully explored. Mining began in 1942, and a concentrate containing 55·98 per cent. Cr_2O_3 with a chromium to iron ratio of 2·97 : 1 has been obtained.

The Ward Property.—This property is 3 miles south east of the

Chromeraine mill. It contains several chromite deposits and, from one of these, samples containing 27 per cent. Cr_2O_3 have been obtained.

Parent Deposit.—This deposit was mined during the last war, and work was resumed for a short time in 1942. A concentrate containing 55·60 per cent. Cr_2O_3 with a chromium-iron ratio of 3·33 : 1 has been obtained.

Hall Pit.—This is an old pit which was re-worked in 1941 and 1942. It consists of massive ore filling an irregular fracture, and is the only deposit of this type which is being worked.

Stewart Property.—The ore here consists of bands of disseminated and massive chromite, the average grade of the former being about 24 per cent. Cr_2O_3 and of the latter being 46·78 per cent. Cr_2O_3.

Although these deposits are profitable to work during wartime, in peacetime they could probably not compete with imported ores. The normal specifications call for ore containing 48 per cent. Cr_2O_3 with a chromium to iron ratio of 3 : 1, lump ore being preferred to concentrates. Beneficiation processes have been worked out by the Chromium Mining and Smelting Corporation, and the lower-grade ores are now being used for the manufacture of ferro-chromium. The price in Canada for ores reaching the above specification is $45·75 per long ton, U.S. funds, f.o.b. Niagara Falls, and there are penalties or bonuses for variations from this standard.

Canadian Talc in Insulators.—Recent beneficiation tests on Canadian talc, carried out in order to investigate its possibilities in meeting a threatened shortage of talc for electrical insulator purposes, have shown that a high-purity product can be obtained from it which is suitable for the manufacture of the highest-grade steatite insulators. These tests, together with an account of the deposits from which the raw material was obtained, have recently been described in an article by H. S. Spence, J. G. Phillips and W. T. Turrall, *Bull. Amer. Ceram. Soc.*, 1943, **22** (8), 295-8, from which the following has been abstracted.

Of the total production of prime white talc in Canada, probably more than 90 per cent. has originated from the Madoc district of Hastings County in E. Ontario, which was developed about 1900. The principal mines are the Henderson (opened in 1900) and the Conley (opened in 1912), which are joined underground for reasons of mutual safety and ventilation, the two shafts being 650 ft. apart. Although operated independently as regards production, they are both owned by Canada Talc, Ltd.

The deposits in these two mines are similar in that a series of veins or lenses 5 to 65 ft. wide and about 1,500 ft. long trending east and west are worked to a depth of about 400 ft. Some 12,000 to 15,000 tons of talc are milled per annum, and at this rate reserves are sufficient for 25 years. The total production from this area to date has been of the order of 400,000 tons.

In the Madoc district, the talc occurs in white crystalline dolomite, of which the mineral is believed to be an alteration product. Two types of talc are known, the first being a relatively hard, pale greenish-yellow, massive and compact steatite, superficially resembling serpentine, and although this type is relatively pure, it gives a rather gritty product on account of its hardness. The second type is a white to pale cream, soft, foliated talc of medium to fairly coarse texture, and it is this which yields the highest quality prime white talc. The two types of talc, however, are not necessarily associated or locally segregated at any particular point. Generally, no attempt at selective mining is made, though a certain amount of high-grade crude may be prepared for ceramic use. Milling practice and air separation is on established lines, and a number of different products are available.

Owing to favourable market conditions for their product, little interest in the beneficiation of this talc has hitherto been shown by the Madoc producers, although a little research had already been carried out on this problem. Consequent on the threatened shortage in the U.S.A. of low-lime and low-iron steatite for electrical insulators, however, fresh laboratory work was carried out by the Canadian Bureau of Mines on the flotation of selected Madoc talc, the most promising results being obtained when pine-oil and sodium carbonate were used as the reagents.

Preliminary trials showed that the selected high-grade crude, which represented 22 per cent. of the total sample and contained 1·72 per cent. CaO, could be cleaned in one operation, whilst the lower grade crude, representing the balance of the sample and containing 10·28 per cent. CaO, required two operations in order to obtain a satisfactory product. These results were sufficiently encouraging to warrant practical trials, and for this purpose, ordinary unsorted, mill-run material was used containing 8·38 per cent. CaO, and this, on flotation, gave a concentrate representing 25·8 per cent. of the original sample and containing only 1·76 per cent. of CaO (1·51 HCl soluble). The percentage analysis of this product was as follows:

Total CaO	FeO	Fe_2O_3	Al_2O_3	CO_2	MgO	SiO_2	H_2O at 105°C.
1.76	0.10	0.29	0.23	2.45	32.20	57.78	5.20

With further cleaning, the CaO content could be reduced to less than 1 per cent., but with lower recovery, though no attempt at maximum recovery is actually made.

Mineralogically, the Madoc material is composed of talc with residual carbonates (dolomite and calcite) and with a little tremolite and other impurities. A substantial proportion of the talc is in the form of fine micaceous flakes compared with the bladed, fibrous and aggregate forms in other commercial talcs.

Subsequently this beneficiated talc was submitted to laboratory and commercial ceramic firing tests, from which it was found that

the soft and non-abrasive Madoc talc fired to a pure white colour, had a low content of both iron oxide and alumina, possessed dielectric properties comparable with those of talcs already used for this purpose, and was more refractory than Californian talc with which it was compared.

Altogether, therefore, it appears that Madoc talc has interesting possibilities for use in steatite electrical insulators, particularly for blending with talcs of inferior refractoriness.

The Graphite Deposits of Ceylon.—Although Ceylon graphite has been worked systematically for 120 years and is probably the best high-grade graphite in the world, our knowledge of the geology and mineralogy of the deposits is still rather scanty. A recent contribution to the subject has appeared in *Professional Paper No. 1, Department of Mineralogy, Ceylon*, in which Mr. D. N. Wadia has written " A Brief Account of the Mineralogy of the Graphite Deposits of Ceylon: A note on the origin of the Graphite."

There are three chief modes of occurrence of Ceylon graphite: (1) disseminated scales or laminae in granulites, schists and limestones; (2) embedded masses, veins, lenses or pockets of almost pure graphite, generally lying parallel to the bedding or foliation-planes of the country rocks which themselves do not contain any graphite. The veins are banded, with fibrous graphite arranged transversely along the walls and foliated or platy graphite in the middle; and (3) pegmatite dykes or quartz veins carrying graphite which proceed from the larger granitic intrusions. The larger graphite bodies are of type (2) and occur in elongated belts running N.N.W.-S.S.E. through the granulitic rocks of the Khondalite Series, or in joint planes more or less transverse to that direction.

The system of rocks which is now considered to be the principal container, if not the producer, of graphite, is the group of acid granulitic gneisses, leptynites, quartzites, garnet-sillimanite rocks, limestones and dolomites, known as the Khondalite System, and regarded as extremely metamorphosed Archaean sediments of varied composition. An insignificant quantity of graphite occurs as an original (syngenetic) constituent of some of these rocks, especially of the sillimanite-garnet-quartz rock (khondalite proper), but the important graphite bodies are of secondary (epigenetic) origin, being obviously introduced into cracks, fissures, faults, foliation and joint planes. Usually the veins have remarkable continuity of direction, running in well defined belts along the prevalent strike of the country rocks. In the Western Province the prevalent strike of foliation of the granulites and of the graphite belts is N.N.W.-S.S.E., but joint planes filled with graphite are also met with lying east-west. In the Galle and Kalutara districts graphite belts persist for many miles, though the width is generally less than half a mile. The linearly disposed mines in the Pasdun korale suggest that some of the belts may continue for more than

50 miles. This directional trend of the more important deposits is too closely associated with the geological structural lines of the country to be accidental. Some of the larger lodes are in the form of bedded deposits of massive graphite. Others are stock-works or massive cavity fillings with no definite axial trend. The smaller veins have a banded structure, composed of parallel bands of fibrous and platy graphite. Usually the fissure veins are a few yards in length and thin out to mere stringers, the groups of veins in an area being connected by branching graphite-filled fissures proceeding from a distance.

Graphite-bearing pegmatites and quartz veins are frequently traceable to the massive vein deposits, and a gradual transition may be seen by the increase of the accessory graphite and the disappearance of the quartz and felspar. The pegmatites have no well defined boundaries, and on the margins of the graphite veins crystals of graphite occasionally penetrate into the country rock where they are accompanied by crystalline calcite, scapolite and other calcareous minerals.

That the occurrence of graphite is restricted to the Khondalite rocks and their granitic injections, charnockites and related bodies, was a fact indirectly recognised by previous writers, especially J. S. Coates. Its absence from the other gneiss systems of Ceylon is equally significant, for although extensively intruded by later granites of several periods these rocks are devoid of mineral deposits. The rocks of the Khondalite group, on the other hand, are characterised by the presence of a host of interesting minerals—graphite, garnets, phlogopite, various pyroxenes and other calc-silicates, sillimanite, pyrites, spinels, apatite, tourmaline, and several gemstones and rare-earth minerals such as thorianite, monazite, ilmenite, zircon, fergusonite, etc. Of these the first six are so abundant and intimately associated as to suggest a paragenetic kinship.

The most frequent associates of the vein graphite are pyrites, quartz, calcite and augite. Of the other minerals occurring in the veins and the immediate surroundings of the graphite-charged stockworks the following are the most common: scapolite, wollastonite, forsterite, tremolite, common hornblende, phlogopite, apatite, kaolin, chloropal, magnetite, garnet, allanite, sphene, molybdenite and lime-felspars. The pegmatitic intergrowth of graphite with garnet, phlogopite, pyroxene, wollastonite, pyrite and molybdenite, not rarely seen in marginal rocks, suggests simultaneous crystallisation of pairs of these minerals at a fairly high temperature. The frequent association of graphite with calc-silicate minerals on the one hand and with charnockite and other magma bodies on the other, witnessed in nearly all areas of graphite occurrences in Ceylon is noteworthy and points to some genetic relationship between them. It is the observation of this relationship in all parts of the Khondalite terrain marked out by the occurrence of workable graphite deposits that has led Wadia to the theory of the

origin of Ceylon graphite outlined below, viz., its origin from limestone by the absorption of the latter by charnockitic intrusions resulting in the production of various lime-silicates and pyroxenes in the magma and the elimination of carbon in gaseous or volatile form. The disseminated graphite of the Khondalites is a primary constituent evidently formed by the metamorphism of carbonaceous constituents of the original shales and sandstones.

The workable deposits are clearly fissure fillings or pegmatitic intrusions, and many of the fissure veins show evidence of considerable pressure, the graphite having been squirted or moulded into a zone of sheared or disturbed rocks. This fact indicates that the veins were not filled by the agency of infiltrating groundwaters or by processes of secretion or excretion from the wall rocks. Everywhere there is proof that the graphite was introduced into pre-existing cavities by injection while it was in a volatile, liquid or plastic stage. These views are shared by previous writers, such as Coomaraswamy, Coates, and Weinschenk, who postulated an igneous origin of the graphite, the carbon having a deep-seated source in magma reservoirs in the interior. Wadia, after four years of study of the Ceylon deposits, submits the following tentative conclusions: "(1) that the loose crystals of graphite occurring as a primary constituent of the Khondalite schists are wholly unrelated to the vein graphite deposits; (2) that the latter are of secondary origin, derived from the bodily alteration by contact metamorphism as well as absorption of carbonaceous strata (limestones, dolomite, calc-gneisses) by intrusive bodies of charnockite and related igneous rocks. The calcareous base of the invaded limestone is converted into the various lime and magnesian silicates, while the liberated carbonic acid under conditions of high temperature and pressure, is dissociated into gas or liquid carbon or reduced to graphite in the presence of hydrogen."

This view requires a close association of calcareous strata with graphite bodies. This is actually observed in a large number of cases, and where it is not, it is possible that calcareous strata may occur at depth along the passages of the intruding magma. Filling of the lodes and veins appears to have been by injection of a plastic mass under pressure. Isolated patches and specks of graphite away from the main lodes suggest small crevices in the rock which offered passage to the CO_2 or CO gases under reduction. In the smaller veins, where an undisturbed comb structure of foliated and fibrous graphite is seen, deposition from a gaseous phase is suggested. The incorporation of limestone by ascending magma is also believed to have been responsible for many of the widespread pyroxene-rich charnockites of Ceylon—the pyroxene-granulites, noritic and basic garnetiferous varieties and the intermediate types of charnockite containing free calcite. Calc-schist, dolomite and limestone bands are observed in all the graphite mining areas of Ceylon, and pyroxenes and phlogopite mica persistently accompany the graphite. No

appreciable quantity of graphite is mined from limestone rock itself, though graphite occurs as scattered flakes in silicated crystalline limestones and calc-granulites.

A well-established fact is that areas of most active graphite mining are the belts of extensive granitisation by intrusions of charnockites. The linear extension for miles of the graphite belts of Pasdun korale and parts of Galle district can plausibly be explained as being due to the breakdown of the limestone bands which in other areas extend along the strike without a break for many miles, with a width of outcrop ranging from 50 to 2,000 ft.

Wadia's theory is submitted tentatively for future observers to test by their own observations. It may be of interest, therefore, to summarise the views of the previous Government Mineralogist, the late J. S. Coates, published in his last paper on "The Geology of Ceylon," *Ceylon J. Sci.* (B), 1935, **19**, 177-178. Coates stated that the graphite veins occur mainly in the charnockite area of the south-west, and to a lesser extent where charnockites and khondalitic rocks alternate, but only where charnockite intrusions are well developed. "No khondalites have been identified in the south-western portion of the island where graphite veins are most frequent." He believed that the graphite deposits originated as pegmatitic intrusions in intensely sheared zones in the charnockites. Graphite was found as an original mineral in the Ceylon charnockites in only about 2 per cent. of a large number of specimens examined. While admitting that the graphite might have been derived from carbonaceous (graphitic) schists absorbed by the invading charnockite magma, he stated that there was insufficient evidence of the existence of such rocks.

The principal mining centres can be roughly grouped into three areas: (i) the Ragedera-Maduragoda-Ruwanwella area in the north, including three of the largest graphite mines in the world; (ii) the Kalutara area and clusters of small pits in Galle, and (iii) the Hambantota-Matara districts in the south. For the present the graphite mining industry is concentrated in the south-west sector of the island, and little prospecting has been done elsewhere. At one time in 1941 there were more than 2,000 pits being worked, but barely a dozen firms employ machinery and mine in depth, the deepest working level being 1,600 ft. in only a single mine.

Geological examination of the Khondalite group outside the mining areas reveals the existence of fissure-veins filled with graphite, and it remains for detailed prospecting to prove that these deposits are of economic value. Such prospecting appears to be called for in the Anuradhapura-Horowupotana-Vavuniya area, where although prospecting will be very difficult on account of the cover of recent deposits, mining conditions will be easier and drainage and pumping far less costly than in the south-west. A new extension of the Khondalite System has also been discovered to the south-east in

the Rakwana-Ambalantola section, and mining leases have recently been granted there.

It is impossible to estimate even approximately the graphite reserves of Ceylon. However, from the fact that in the last 62 years for which reliable statistics are available Ceylon has exported 1,210,000 tons of graphite, and that an annual production of 30,000 tons is easily maintained without the use of power plant in 98 per cent. of the mines, it is assumed that the reserves of ore in sight must be very large. It is also reasonable to presume the existence of prospective ore over fairly wide blocks in the vicinity of the majority of the existing mines on much the same scale and conditions of occurrence as the proved and probable deposits. The recent geological work has extended the area of the graphite-bearing formation by nearly 50 per cent., and it is already clear that this new area holds out promise of a number of workable deposits.

Zircon-Rutile Beach Sands in Australia.—The zircon-rutile-ilmenite sands which occur along the coast of New South Wales from the Shoalhaven River northwards to the Queensland border have been worked since 1934, and were described in this BULLETIN, 1939, **37**, No. 3, 428-433.

According to a note in *Industrial Australian and Mining Standard*, February 15, 1944, pp. 35-36, the black sands extend northwards across the border and along the coast at least as far as Southport, in Queensland, where the Department of Mines has taken an active interest in this industry, and mining operations began at Little Burleigh in 1941. A 75 per cent. natural concentrate was obtained, and treated at Southport, with the production of a final concentrate containing approximately 45 per cent. zircon, 25 per cent. ilmenite, 25 per cent. rutile and 5 per cent. garnet, monazite, etc. Other concentrating plants have been erected at Tugun and Currumbin in Queensland.

It is interesting to note that the treatment of the black sand deposits along these coasts has recently been the subject of a conference, called in Sydney by the Director General of War Organisation of Industry. An electrostatic separator for the production of clean rutile concentrates having recently been imported into Australia, the conference considered where this could be placed to the best advantage, and also the proposed rationalisation of the industry.

Fluorspar in South and South-West Africa.—South Africa has had an export trade in fluorspar for more than 20 years, and with increasing industrialisation her domestic consumption of fluorspar is growing. A comprehensive report on fluorspar in the Union and South-West Africa recently issued by the Union Department of Mines (*Geological Series Bulletin* No. 14) is therefore an important

contribution to our knowledge of the Empire's resources. The principal deposits are in the Transvaal. The first to be worked were replacement deposits in the dolomites and cherts of the Dolomite Series of the Transvaal System in the Marico district, but after yielding some 60,000 tons of high-grade spar these deposits, with few exceptions, have either been worked out or workings have had to be abandoned on account of waterlogging. The present supplies are largely obtained from veins and pipes in the Red Granite of the Bushveld Igneous Complex, where there are good reserves and wherein lie the best prospects for any future expansion of the industry. To the end of 1940 about 100,000 short tons of fluorspar had been produced in the Union, and the total reserves of the Union are now estimated at 750,000 tons. In South-West Africa reserves total several million tons of somewhat low-grade fluorspar.

The most important fluorspar deposits in the Marico district of the Western Transvaal are those on the farm Buffelshoek 284. One of these, known as the "Gravel" deposit, which lies a quarter of a mile west of the south-east beacon of Buffelshoek 284, and about 9 miles by road from Ottoshoop Station, is of a rather unusual type. The fluorspar has partially replaced the dolomite, and the unreplaced dolomite has later been leached out, leaving residual manganese earth. The resultant deposit consists of thin alternating layers of granular fluorspar and manganese earth. The deposit has not yet been fully explored, but it is known to be at least 13 ft. thick, it contains 50-60 per cent. fluorspar, and it is considered that reserves are of the order of one hundred thousand tons. Early attempts at concentrating the ore by flotation proved unsuccessful, but recent tests have shown that the adoption of the dry tabling method of concentration might prove more satisfactory.

A blende-fluorspar deposit lies about one mile north-east of the south-west beacon of Buffelshoek 284, and was partially developed as a source of zinc ore during the period 1908-1914. The mineralised zone is pipe-like in shape, covering at the outcrop a circular area about 300 ft. in diameter. The depth is uncertain, but should it extend for as much as 80 ft. it is estimated that the fluorspar reserves would be about 37,000 tons.

The Oog van Malmanie 101 fluorspar deposit is situated a little to the east of the Ottoshoop-Lichtenburg main road, and about 9 miles from Ottoshoop Station. It was worked and the deposit partially depleted between the years 1917 to 1926, during which period about 30,000 tons of high-grade spar, containing about 98 per cent. CaF_2, were produced and exported to America. The original outcrop covered on the surface an area only about 10 ft. in diameter, but it expanded in depth, until at the bottom of the quarry the E.-W. axis was about 80 ft. and the N.-S. axis about 40 ft. It is not known whether the deposit extends to greater depths, and boreholes should be put down to ascertain the facts.

Other fluorspar deposits and quarries are known in the Dolomite Series, and some have been good producers. Blane's No. 1 Quarry on the farm Buffelshoek 284 was worked by Western Quarries, Ltd., and it yielded some thousands of tons of good-grade ore. Another deposit on Witkop 288 was worked by the same company during the years 1925-1936, but production figures are not available.

The largest fluorspar deposits of the Union are found in the Red Granite of the Bushveld Igneous Complex, occurring as vein deposits filling faults and fissures in the granite, or as replacement deposits often pipe-like in form, or in veins associated with quartz and barite.

The Gilspar fluorite mine on Ruigtepoort 1373, in the south-western part of the Waterberg district, is considered to be the largest of the South African deposits, and the ore reserves are estimated to be 400,000 tons. The ore-body is a replacement deposit and pipe-like in form. The mine was worked by the Warmbaths Fluorite Syndicate in the years 1929-1930, after which it lay idle until 1936, when it was taken over by Fluorite and Minerals (Pty.) Ltd. During the years 1936-1940 no less than 15,292 tons of fluorspar were produced.

The Big Ben Mine on Slipfontein 528, in the Rustenburg district, is another large pipe-like replacement ore-body, with estimated reserves of 12,500 tons. It is also worked by Fluorite and Minerals (Pty.) Ltd., who during the years 1939-1940 produced 3,315 tons of fluorspar valued at £6,610.

A fluorspar deposit where mineralisation has taken place along a fault in the granite occurs on Vischgat 1091 in the Waterberg district. This deposit has not been developed, but assuming the vein to persist to a depth of 50 ft. it is estimated that the reserves amount to 6,700 tons of high-grade ore.

A fluorspar deposit which has not been exploited commercially but appears worthy of examination, occurs in the Rooiberg Felsites on the farm Roodeplaat 314 in the Pretoria district. It is interesting in that it occurs in an endogenetic volcanic breccia, in which fragmentation was caused by deep-seated volcanic movements accompanying the felsite extrusion and associated with fluorine vapours. Specimens of the fluorspar appear to be very pure, but the quantity available is not known.

Fluorspar is also found in the Transvaal associated with alkaline igneous rocks. These deposits are generally speaking of little commercial interest on account of the intimate association of apatite with the ore.

Outside the Transvaal fluorspar is known to occur in Zululand and North-West Cape Province, and deposits are also known in South-West Africa. These deposits have not, however, been recently examined, and they are not considered to be of economic importance, partly because the deposits are small, and there are difficulties in obtaining adequate labour and transport facilities.

A very large deposit, with reserves running into millions of tons, occurs on the farm Marburg 1 in the Otjiwarongo district of South-West Africa. The massive ore varies from 70 to more than 90 per cent. CaF_2, and should there be a considerable expansion of the iron and steel industry in the Union, this deposit might be exploited.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE MINERAL RESOURCES OF AFRICA. By A. Williams Postel. *African Handbooks: No. 2.* Pp. 105, 8½ × 5½. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1943.) Price 9*s.* 6*d.*

This little book is intended as a handy summary for the American layman interested in Africa's position in world affairs. The minerals of Africa are divided into five groups, base metals, non-ferrous metals, non-metallics, etc., and the distribution and production of each is considered in turn. In each case comparison is made with world production, and the significance of African output to United States requirements is indicated. The uses of each mineral are briefly explained, and American prices are quoted. Madagascar is treated separately in brief, and there is a short chapter on water power and water supplies.

The salient facts concerning African minerals are presented, but in points of detail the book is open to many criticisms and bristles with errors. Mineral production receives far more attention than mineral resources, despite the title, and although the book is called an African Handbook, the subject is treated from an American rather than an African point of view, many important aspects of the mineral industry in relation to the economic development of Africa being ignored. For example, in the section on iron, it is stated that Africa produces a good quantity of iron ore, and the deposits in six countries are briefly described in two pages, but it is not pointed out that there is not a single modern blast furnace in Africa outside the Transvaal, which means that 145 million Africans depend on imports and old petrol cans for their iron and steel requirements.

In several sections the information has been taken from books already rather out of date even before the war started. There is therefore, for instance, no indication of the vigorous expansion of gold mining during the last ten years in such countries as Tanganyika and Kenya, and the water supply position in several countries is described as it was known in 1930, and no account is taken of the subsequent work done by Geological Surveys and of the thousands of wells and boreholes made in British colonies with the aid of the

Colonial Development Fund. Place names, too, are frequently misspelt, and in several cases deposits are described under the heading of the wrong country. The book will serve a useful purpose if it calls attention to the need for a better book on this subject.

(1) Geology in the Service of Man. By Prof. W. G. Fearnsides, F.R.S., and Dr. O. M. B. Bulman, F.R.S. Pp. 158. (2) Minerals in Industry. By Prof. W. R. Jones, Pp. 149. (3) Metals in the Service of Man. By Dr. A. Street and Dr. W. Alexander. Pp. 192. *Pelican Books.* $7 \times 4\frac{1}{4}$. (Harmondsworth, Middlesex: Penguin Books Limited, 1944.) Price 9*d.* each volume.

The general aim of these eminently readable little books is to direct popular attention to the fundamental and vital importance of geology, minerals, and metals in our everyday life, in the belief that an increasing awareness of the principles involved can have no other than a salutary effect in post-war reconstruction. Though designed primarily for the ordinary reader, these little books, all of which are appropriately illustrated, are a delight even for the expert to read.

Professor Fearnsides and Dr. Bulman emphasize the fact that geology is the broadest in scope of all the natural sciences, with nearly all of which it has close contacts. The principles of geology are introduced under five main chapter headings, dealing with the crust of the earth, the building of continents, the development of scenery, an epitome of the geological history of Britain, and the construction and use of geological maps. The authors devote the remaining seven chapters to "some applications of geology," and discuss the geology of water supply, soils and petroleum, engineering geology, mineral supplies for heavy industries, non-ferrous metals and chemical supplies, and gemstones. Two appendixes give in tabular form a classification of igneous and sedimentary rocks, and the geological systems and formations. A short, selected bibliography, and a 4-page index are also provided.

Professor Jones's little book on economic minerals is a marvel of compression, accurately compiled and written in eminently readable style. Excluding fuels and water, the principal economic metals and minerals are described in alphabetical order, fifty-five subjects being dealt with in all, but, under abrasives, platinum metals, sillimanite minerals, etc., more than one individual metal or mineral is covered. Each of these sections is divided about equally into two parts, the first dealing with the nature and uses of the commodity, and the second with occurrence and production. The thirty-one figures consist of graphical representations of pre-war production, and maps showing world distribution of the principal deposits of various minerals.

The work by Dr. Street and Dr. Alexander presents an excellent and indeed fascinating account in simple language of modern metallurgy. While the theme of the book is the usefulness of metals,

this is accompanied throughout by a skilful explanation of the fundamental principles of metallurgy. The extraction of metals from their ores is first discussed, with iron and aluminium as illustrations. Next, the general principles of alloy formation, metallography, and the atomic structure of metals and alloys are considered and the processes of shaping metals, testing and corrosion are explained. Separate chapters are then devoted to the important metals—iron and steel, the light metals, non-ferrous metals, and some minor metals. Riveting, soldering, welding, and powder metallurgy complete the "syllabus," and the book concludes with a topical comparison of the metallic resources of the United Nations and the Axis Powers, and some comments on the future of metals. The book is illustrated by photogravures and by diagrams drawn by Francis Condrill, several of which add an original humorous touch which goes well with the lively style of the authors.

Standard Methods for Testing Petroleum and its Products. Fifth Edition. Pp. xxxiv + 477, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Institute of Petroleum, 1944.) Price 15*s*.

This book, the fourth edition of which was reviewed in this Bulletin, 1943, **51**, 125, has grown in two years from 390 to 477 pages, and the number of tests described has increased from 75 to 97. The additions, according to the Foreword, are principally methods relating to chemical products derived from petroleum and asphaltic bitumen emulsions. Some amendments have also been made to existing methods. All standard tests likely to be required by the petroleum technologist are described in detail, and it is unnecessary to add to the appreciative remarks made about the previous edition concerning the value and usefulness of the work to those engaged on the technical side of the industry.

A small point about the serial designation of the methods is not quite clear to the reviewer, and may be mentioned, though not in a spirit of criticism. One example may be quoted, but similar instances occur: The tests for aromatic content and ash content, which in the Fourth Edition were numbered 3/42 and 4/42 respectively, are now 3/42 and 4/44, and the reason for the lack of uniformity in numeration is not obvious.

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EMPIRE EDUCATIONAL FACILITIES

EXHIBITION GALLERIES, LANTERN SLIDES, FILMS, LECTURES, Etc.

NOTES

Exhibition Galleries.—In spite of the wartime preoccupations which, for the present, must absorb the normal leisure time of most folk and thus seriously curtail their opportunities for visiting public museums and art galleries, the Exhibition Galleries continue to attract very satisfactory attendances of visitors. During the past six months, a total of 29,854 is recorded, a figure which shows an increase of 8,847 compared with the similar period of last year. Visits of organised parties, mainly classes of school children and parties from units of H.M. Forces show similar increases, namely 114 parties against 60 parties.

The services of guide lecturers have been in almost daily demand, and on these occasions the comments and inquiries made reveal a very real public awakening of interest in Empire affairs. This is doubtless due in a large measure to the prominence which these matters have received both in Parliament and in the Press, but contributory causes may be found in the presence of Dominion, Indian and Colonial troops in London which in turn has evoked a general desire to learn more of the countries from which they have come; and also in the control and rationing of raw materials which has certainly created an equally general interest in what these materials really are, how they are obtained, and what they are used for. It is gratifying to be able to record that the answers to all these questions are to be found in one or other of our Empire Courts.

Additional to these visitors are the Colonial Service officers, who, during their periods of leave in this country, have found time to visit the Imperial Institute. A list of them is shown at p. 148.

Among distinguished visitors who have been received by the Director and have made a tour of the Galleries or visited a particular Court are:

February 2: Dr. Heindel, Director of the American Library of Information, American Embassy.

February 2: Sir Paul Dukes, K.B.E.

February 2: Prof. H. G. Champion, C.I.E., M.A., Director Imperial Forestry Institute, Oxford.

February 4: Mr. Leif Egeland, Minister for the Union of South Africa to Sweden.

February 7: Lt.-Col. L. E. Barton, C.I.E., British Resident, Kashmir.

May 12: Sir John Humphrey Wise, K.C.M.G., C.B.E., I.C.S., Counsellor to H.E. the Governor of Burma.

May 22: Mr. F. H. Yarnold, I.C.S., Deputy Secretary, Defence Department, Government of Burma.

May 26: Prof. E. J. Salisbury, C.B.E., F.R.S., D.Sc., F.L.S., Director, Royal Botanic Gardens, Kew.

June 1: H.H. The Maharaja of Jammu and Kashmir.

New Exhibits.—The following paragraphs relate to the more outstanding additions to the Exhibition Galleries during the past six months.

Indian Cigarette Tobacco. It is not generally appreciated that India is one of the largest tobacco-producing countries in the world. As a matter of fact, on the basis of 1936-37 statistics, India stood first among the world's tobacco producers with 1,497,000 acres, growing 1,375 million lb., while the United States of America, generally regarded as the world's largest producer, came second with 1,438,000 acres and 1,155 million lb.

This lack of appreciation of India's tobacco production is due to two main causes. Firstly, India, with a population exceeding 388,000,000, is a large consumer of tobacco, the annual consumption being over 1,000 million lb. The result is that India's export of tobacco barely amounts to 3 per cent. of the world's total export. Secondly, the Indian plant is mainly of the type yielding a strong, dark, thick tobacco demanded by the local consumer. Only 2 per cent. of India's total production is of the virginia type which is in increasing demand in international trade.

This latter variety when flue-cured is known as "Golden Leaf," and is of high quality eminently suitable for cigarette making. The finest quality flue-cured virginia tobacco is of a bright lemon colour and a fine silky texture with very little blemish or damage. To produce tobacco of such quality a considerable amount of patient research has been, and is being, undertaken to improve not only the quality of the leaf but also the curing. This work has to a large extent met with success and during recent years the demand for Indian virginia flue-cured tobacco has considerably increased in the British market. Whereas the import of Indian unmanufactured tobacco into the United Kingdom amounted to only 4 million lb. in 1922, it has risen to well over 32 million lb. in 1938.

Almost the whole of the unmanufactured tobacco exported to the United Kingdom is from the Guntur area in the Madras Presidency, and here credit is due to the Indian Leaf Tobacco Co. Ltd., who, while encouraging the increase in plantings of the indigenous type of tobacco, also introduced the virginian variety and fostered its development both in cultivation and in curing, so that to-day

the production of this virginian flue-cured tobacco has become firmly established.

As a record of this excellent work, a series of twelve illuminated coloured transparencies has been installed in the Indian Court, adjacent to the Tobacco diorama, to illustrate the cultivation and curing of virginia cigarette tobacco in the Guntur District, Madras. Under the head label of " India's Virginia Cigarette Tobacco " the transparencies portray the sowing of the seeds in the nurseries; spraying the seedlings with insecticide; lifting the seedlings for distribution; transporting the seedlings to the distribution centre; collection of seedlings by distant smallholders; a well-grown field of tobacco; loading the curing barn with green tobacco; the cured tobacco as it leaves the barn; checking bales of tobacco at a local depot; transporting tobacco to the main factory; hogsheads of prepared tobacco maturing in store, and lightering hogsheads of matured tobacco for export.

" Burma's Great Highway—the Irrawaddy River."—The relief model map of Burma in the Burma Court bearing this title has proved of great interest to visitors owing to the prominence given in the Press to the present campaign in Burma. The map, when made, only included place-names which were relevant to its title. Since the war some hitherto obscure places have become very prominent owing to their strategic importance and in order to keep the map abreast of the times, it was thought desirable to indicate additional place-names. Some thirty names have, accordingly, been added, among them being the now familiar Rathedaung, Mayu river, Buthidaung, Tiddim, Tamu, Tamanthi, Mogaung, Hukawng valley and Imphal (Manipur).

Canadian Pacific Air Lines.—The railways of Canada have always evinced the most commendable enterprise in fostering the modern development of this great Dominion far in excess of their normal functions as railways. As a case in point the Canadian Pacific Railway, after spanning the country from coast to coast, extended its activities by means of steamship lines over two oceans, the Atlantic and the Pacific. It is therefore perhaps not surprising to find that a further subsidiary has already become one of the world's chief commercial air operators. Some indication of the part which this company is playing in the development of Canada's airways is given in a display which has recently been installed in the Canadian Court. Two maps show how the Far North has been linked to the South by a number of air routes, while a set of excellent photographs illustrates a number of the more interesting phases in their operation.

A new Relief Model of Canada.—One of the most interesting features of the Exhibition Galleries is the series of relief model maps provided to convey to visitors some idea of the general contours

and relief of the overseas countries with which they deal. The latest addition to this collection, and certainly one of the finest, is a large relief model map of the whole of the Dominion of Canada, which has now been installed at the south end of the Canadian Gallery, just inside the West Public Entrance and immediately below the existing pictorial wall-map of the Dominion. Each of these maps is complementary and supplementary to the other, and their juxtaposition, combined with the fact that both are on the same scale, namely 35 miles to the inch, enables the visitor to make cross references from one to the other with a minimum of effort. The vertical scale of the new model is 5000 ft. to the inch, and although, when compared with the horizontal scale, this leads to gross exaggeration of the actual relief of the country, it does bring out well its relative contours and throws up, in almost startling manner, the Rocky Mountains, with their subsidiary mountain ranges and foothills.

Sir Francis Drake.—As a fitting companion to the statuette of Sir Walter Raleigh which, as already recorded (this BULLETIN, 1943, **41**, 148), was installed last year in the British Guiana Court, a bronze statuette of his contemporary, Sir Francis Drake, has now been provided. It stands at the entrance to the West Indian Court, overlooking the relief model map of the Caribbean, the region in which so many of Drake's exploits were conducted. The statuette is the work of Mr. Herbert H. Cawood, A.R.B.S., and the photograph opposite (Plate I) gives an excellent impression of his interpretation of Drake's personality. The descriptive label attached to the pedestal reads as follows:

Sir Francis Drake

(*c.* 1545-1595)

"Francis Drake, believed to have been born in 1545 near Tavistock, Devon, was educated by his kinsman Sir John Hawkins, and after apprenticeship on a sailing ship became purser at the age of 18. When 22 he was captain of the 'Judith,' and at San Juan de Ulloa under Sir John Hawkins he acquired a great reputation for gallantry. Returning to England, he obtained a privateering commission in 1570 and in 1572 he sailed with 2 small ships, later joined by a third, to attack the Spaniards in the West Indies. With his small squadron he plundered the Spanish town of Nombre de Dios, crossed the isthmus of Panama, and played havoc with Spanish shipping. His ships returned to Plymouth full of plunder on 9th August, 1573, and he rose in popular esteem through the wise use he made of his riches.

"After the death of Essex in 1576, Drake was presented to Queen Elizabeth, and obtained the means to carry out the expedition which has immortalized his name, namely an attempt to reach the South Seas by the Straits of Magellan. The fleet of 5 small vessels

SIR FRANCIS DRAKE.

A Statuette in the West Indian Court of the Exhibition Galleries of the Imperial Institute.

[*facing page* 140

with a total crew of only 166 men sailed on the 13th December 1577, reached the coast of Brazil on 6th April 1578, and entered the port of St. Julian on 19th June 1578, where they stayed two months to re-provision. Entering the Straits on 21st August 1578, their passage took sixteen days. After a storm, Drake, in the 'Golden Hind,' was separated from the remaining vessels of his fleet, so he proceeded alone northwards along the coast of Chili and Peru, taking every opportunity to seize Spanish ships and to attack the Spaniards on shore until his men were satiated with plunder. Coasting north towards the Straits of Juan de Fuca in an unsuccessful attempt to find a passage back to the Atlantic, he landed and took possession of the country in the name of Queen Elizabeth, naming it New Albion. Sailing thence on 26th July 1579 he visited the Moluccas, Celebes, Java, rounded the Cape of Good Hope and entered Plymouth by the end of September 1580, the first Englishman to circumnavigate the world. Shortly afterwards he sailed to Deptford, where Queen Elizabeth knighted him on board the 'Golden Hind.' In 1581, he became mayor of Plymouth, and on the outbreak of war in 1585, he led a fleet to the West Indies and captured many Spanish settlements there. When in Lisbon in 1587, hearing of a fleet being prepared at Cadiz, he entered that port and destroyed 10,000 tons of shipping, a feat he afterwards spoke of as 'singeing the Spanish King's beard.' Under Lord Howard he served in 1588 in the fight with the Spanish Armada and during the next year with Sir John Hawkins on an expedition against the Spanish colonies in the West Indies. During the course of this expedition he died of dysentery on board his ship near the town of Nombre de Dios on 28th February, 1595 and was buried at sea."

The Evolution of a Statuette.—With this latest addition the collection of statuettes of Empire Builders in the Exhibition Galleries now numbers seventeen. They have aroused considerable interest, and appreciative comments by visitors have frequently been accompanied by inquiries as to how they are made. As Samuel Butler wisely remarked, "An Art can only be learned in the workshop of those who are winning their bread by it," but the following notes, prepared in collaboration with Mr. Cawood, the sculptor responsible for several of these statuettes, will it is hoped give some idea of the nature of the operations involved.

Before any statuette reaches the Exhibition Galleries in its final form in bronze, it has already appeared as a finished prototype no less than four times—first as a small sketch model in plasticine; then as a full-sized statuette in solid clay; then as a plaster cast; then as a wax figure, and it is from this "wax" that the final bronze is cast. But, even before the sketch model is started on, considerable research must be made to obtain particulars of the character, life, occupations, etc., of the subject to be portrayed, as well as details of costume (dress, accoutrement, etc.). All this data

must be collected, studied and selected so that the finished statuette shall not be a mere inanimate dummy but rather a crystallized living entity which radiates something of the character, vitality and purposefulness of the Empire Builder concerned. For example, the pose of the figure, although static, may indicate either restfulness or action ; the manner in which a hand is made to touch a sword-hilt may convey either the "caress" of a courtier or the "grip" of a soldier. Only when all these points have been thoroughly absorbed, does the sculptor feel confident to express them in the actualities of the sketch model, a miniature in plasticine which forms the basis of examination and discussion by a selection committee. When this miniature has been approved, it is reproduced in its full 3-foot size in modelling clay. This clay even when finished is still only in purely temporary form, and, to render it semi-permanent, a plaster replica is made by means of a process known as "waste-moulding." The clay statuette is divided into a number of areas (as few as possible) by small continuous fences of brass foil built up by forcing the foil edgewise into the clay along convenient contour lines, and each "field" so made is filled with coloured plaster of paris. Thus, the whole clay model becomes encased in plaster, the individual sections of which are separated by the brass fences. When the plaster is quite set the foil fences are removed and each section of the waste mould is prized off, the clay model being inevitably destroyed in the process. The sections of waste-mould are next thoroughly cleaned of adherent clay and are then reassembled around any necessary reinforcing rods, and are bound together with cords. The waste-mould is then upturned and its interior is filled with fluid white plaster of paris. When in turn this plaster has set, the cords are removed and the waste-mould is chipped away, the difference in colour between the two plasters making it easier to see when the chisel is approaching the surface of the cast. With the last pieces of waste-mould removed and the joint seams trimmed away, there remains an exact replica in plaster of the original clay statuette. This plaster statuette, although permanent enough as a studio record, is not sufficiently enduring for permanent exhibition in public galleries and must therefore be converted into bronze by a process of casting which will provide the greatest degree of accuracy, and here the "cire perdu" or "lost wax" process is the best. This process entails the production of an intermediate statuette in wax and the fact that this statuette becomes "lost" in the course of the process gives it its name.

In the production of this wax statuette the plaster cast is first shellac'd and oiled and is then loosely enrobed in a thick blanket of clay. Around this is built up a plaster piece-mould. When it has set, the piece-mould is opened, the clay blanket is discarded and the mould is rebuilt around the cast, a cavity now replacing the clay blanket. Into this cavity is poured a warm gelatine mixture, which on cooling sets into a firm elastic jelly.

The piece-mould is again dismantled, each section now bearing its own gelatine impression of that part of the statuette. The gelatine being elastic easily withdraws from any undercut details around which it had shaped itself, and springs back into shape when freed. All is now ready for the actual construction of the wax figure. First the gelatine surface of each section of the piece-mould is painted with hot founders wax to ensure that all detail is adequately covered, the edges are cleaned of surplus wax and the piece-mould is reassembled and bound with cords. Hot wax is now poured in, and after a few seconds emptied out again, leaving a thin layer of wax over the painted waxes and joining all together. This pouring is repeated again and again until the mould is sufficiently coated (usually $\frac{1}{4}$ in.-$\frac{1}{2}$ in.). It is the thickness of the wax shell so formed which decides the thickness of the bronze in the finished statuette. When the wax shell has set and while it is still in the mould, its hollow centre is filled with a creamlike mixture of plaster, brickdust and sawdust, and this mixture on solidifying provides both a firm support for the comparatively fragile wax figure, as well as a casting core for the ultimate bronze.

The piece-mould is now opened, releasing the wax figure (apparently made of chocolate) with its firm solid core. This figure is suitably "touched up" and when this work is completed a number of thin iron spikes are driven through the wax into the core at suitable intervals and are left protruding hedge-hog fashion. These spikes act both as core supports and distance pieces when, later, the metal is poured. At this stage provision must also be made for the "pours" and "gates" which will allow the molten bronze to reach every part of the statuette before the metal cools and also for the "air vents" which will prevent the formation of air pockets during the process of pouring. These all take the form of rods of wax, one end of each being attached to the surface of the wax figure and the other being bent down to well below its base. The several pours are brought together to form the one large pour through which the cast will eventually be made.

All is now ready for the completion of the casting mould, which is similar in composition to the core and is applied in liquid form. First the wax figure with its iron spikes and wax rods is carefully painted with the mould composition. When this has set, other coats are added, the outer ones being plastered on until all but the free ends of the pours and vents are thickly coated with some three inches of composition. The mould so formed is allowed to set and then becomes, with its thin wax shell and solid core, one united mass. This unit is then placed in a furnace which is gradually heated. At an early stage the wax melts and runs out, leaving the core firmly held in position by the iron spikes, and the "statuette" in all its detail suspended as a kind of "aerial ghost" represented by the cavity between core and mould. The "pours," "gates" and "air vents" have been similarly emptied and now take the form

of channels in the mould. When all wax is "lost" the mould, with its core, is heated to cherry redness to harden it and make sure that every particle of moisture has been driven off. It is then allowed to cool off. When cool enough to handle, the mould is lowered into a casting pit and packed around firmly with dry sand.

The molten bronze is now steadily run into the main pour, and by means of the subsidiary pours and gates finds its way into all parts of the statuette cavity, the hot gases passing out by means of the air vents.

As soon as the metal has solidified the mould is broken away and, if need be, the core is raked out. The pours, gates and vents, now represented by rods of metal, are cut away, the scars being planished down and any detail on them chased in. The iron spikes are withdrawn, the resultant holes being plugged with sections of the rods already cut off, and these likewise are planished down and chased over. These plugs being of the same metal as the statuette itself leave no visible trace of their presence.

With this last job finished, the "constructional" work on the statuette is substantially at an end. The exact form of the statuette with all its intricacies first fashioned in the plastic clay has now been transferred first to the interior of the waste-mould; thence to the exterior of the plaster cast; from this to the interior of the jelly mould, then to the exterior of the fragile wax shell; to the interior of the casting mould, and finally to the bronze itself.

All that now remains to be done is to clean the bronze to the brightness of a new penny, to affix any item such as a sword which for convenience may have been cast separately, and to give the whole statuette the necessary chemical treatment which engenders a suitable patina. When all this has been done the statuette is ready to take its place in one of the Empire Courts of the Exhibition Galleries.

Empire Lantern Slide Library.—During the six months October 1943 to March 1944 covered by this report 45,080 lantern slides have been issued to schools and lecturers in the United Kingdom. The details are shown below.

	1943. Oct.	Nov.	Dec.	1944. Jan.	Feb.	March.
United Kingdom	180	180	540	240	300	480
Australia	420	480	60	420	1,020	180
Canada	720	720	420	660	1,680	1,320
New Zealand	360	360	240	240	480	240
South Africa	420	300	60	420	600	360
India	660	1,380	660	1,140	1,440	840
Burma	240	540	240	300	420	240
The Colonial Empire	2,640	3,240	1,800	3,420	4,200	2,820
Products of the Colonial Empire	240	360	300	60	420	300
General Tours	360	240	240	240	300	360
History	300	300	120	120	180	120
	6,540	8,100	4,680	7,260	11,040	7,260

A new Picture Talk on The Gambia has been written by Sir Thomas Southorn, K.C.M.G., K.B.E. Sir Thomas opens with a brief history of the Gambia river, the suppression of the slave trade, the declaration of a Protectorate and the growth of the groundnut industry. The means of communication and transport are illustrated and followed by pictures of the African chiefs, their peoples and their customs. The talk closes with a reference to the relation of the Gambia to the rest of the Colonial Empire and the hope that expenditure and research under the Colonial Development and Welfare Act of 1940 will lead to a balanced and prosperous future for the country.

Miss Cornelia Sorabji, D.C.L. (Oxon), Barrister-at-Law, Calcutta, has written a general talk on India entitled "All-India Tour." It describes a journey from Bombay through Southern India *via* Hyderabad and Mysore to Madras and Travancore, followed by a second journey through some of the States ruled by Indian Princes beginning with Baroda, through Gwalior, Udaipur, Rajputana, Jodhpur and Jaipur to Bikanir ; and finally a third journey through British India from the Sukkur Barrage in Sind up to the North West Frontier, then through the United Provinces following the River Ganges to Patna, Gaya, Calcutta and Darjeeling—across to Assam and so back to New Delhi and Simla.

Central Film Library.—The number of films in the Library and the circulation of the films continue to increase, although a number of older films have been withdrawn ; many borrowers have now been borrowing films regularly for many years. On September 1 1943, as was reported in BULLETIN, Vol. 41, No. 4, there were 764 different films in the Library, and by March 31, 1944, the number had increased to 800. The total number of copies of these films in circulation on March 31, 1944, exceeded 12,000.

Among the new films about the Overseas Empire now in the Library are the following : Canada : "Prairie Gold," "High Over the Border," and "North-West Frontier" ; Australia : "Aussi-oddities," "Snow on Buffalo," "Golden Grain," "Follow the Sun," and "Conquest" ; New Zealand : "Maori Movielogue," "Sunshine Province," and "Broad Acres" ; South Africa : "Animals in Wonderland," "On Tour in South Africa," "In the Land of the Red Blanket," "Swazi People," "Marriage Customs of the Amazulu," "Mountain Waters," "Song of the Reel," "The Blue and Silver Way," "The Day Awakens," "Moods in the Forest" and "The Sea" ; India : "Made in India," "Changing Face of India," "Grand Trunk Road," "Covering With Affection," "Tins for India," "Our Heritage" (Indian Architecture), "Indian Handicrafts," "Indian Rubber" ; Colonial Empire : "Peoples of Kenya," "Almost Arcady," "Mediterranean Island" and "Malta G.C."

In March 1944 the first two of a new series of Ministry of

Information films entitled "Know Your Commonwealth" were added to the Library; they are "New Zealand" and "South Africa" and each lasts 15 minutes.

Distribution figures for the period September 1, 1943, to March 31, 1944, compared with the same period for the previous year, were as follows:

	1943-44.	1942-43.
Empire and United Kingdom .	23,833	23,063
G.P.O.	5,059	4,989
Ministry of Information . .	44,777	40,437
	73,669	68,489

Empire Lectures to Schools.—The Empire Lectures Scheme to schools opened its fourth session in September 1943, and the period covered by this review is in respect of the six months which ended in February 1944. During this period 1,240 lectures were delivered to audiences numbering 186,773 school children. The figures for the corresponding period a year ago are 653 lectures delivered to audiences aggregating 115,836 school children.

In each successive report on the Lectures Scheme its continued expansion has been noted. Whereas the number of lectures arranged during the 1941-42 season was 768, 1,476 lectures were delivered during the 1942-43 season. During the current season, which ends in August 1944, it is expected that the figure will exceed 2,250. It is gratifying to note that this progress has been accomplished without the recruitment of additional staff and at a progressively lower average cost per lecture. The reasons for this satisfactory feature are (*a*) because, generally speaking, the single lecture has given place to the lecture tour, and (*b*) that Education Officers throughout the country are lending their valued co-operation.

It was not long after the inauguration of the scheme that head teachers came to realise that the lecturers made available by the Imperial Institute (men and women who have lived for many years in the overseas Empire and in many cases nationals of the countries about which they speak) are able to supply a need which can rarely, if ever, be met by the average teacher. Teachers recognise the unique feature of the scheme and testify to the profit which they themselves derive from these lectures; and because of the uniform good quality of the talks provided, they are eager to arrange lectures well ahead as an indispensable part of the school curriculum.

In administering a scheme of this kind it is not unusual to receive letters of appreciation, and the Empire Lectures Scheme is no exception. Indeed, reports are specifically requested for the express purpose of assessing the degree of success of the lecturers, and in order to obtain the views of experienced teachers in regard to methods of treatment and the reactions of the children. Close attention is paid to these reports by the Imperial Institute, and the

lecturers are enabled to profit by the advice contained therein. It may be not inappropriate to quote a few of the remarks made by discriminating head teachers. One writes: "the lectures are of great educational value and interest, and I have highly commended them to H.M. Inspector of Schools." Another sincerely hopes "that this work is not a temporary undertaking and that it might become a regular feature of education." Yet another writes: "I shall be glad to know when your lecturers are in the Birmingham area as I should like to make more use of the Scheme in future because your lecturers can give what few text books can."

Again, although lecturers may possess a fund of knowledge and information, not all are able to convey their knowledge and experiences in a way likely to arouse and maintain the interest of both young children and adolescents. The Institute is for this reason particularly careful in its choice of lecturers, and head teachers are quick to appreciate this feature of the scheme, as the following extracts from their reports indicate: "the boys feel they are listening to someone who knows, because he has been there; it is this freshness that appeals"; "the lecture was first rate, just what I wanted and what the young really enjoy"; "I have never known the boys so enthusiastic, and I, too, thoroughly enjoyed the lecture."

The potentialities of the scheme are enormous and cannot fail to be of the utmost value in promoting knowledge and better understanding of the peoples of the Empire.

Inter-Empire Correspondence.—During the past few months the Imperial Institute has inaugurated a scheme to put children in schools of the Overseas Empire in touch, by correspondence, with children in this country. Letters were addressed to Directors of Education in the Colonies seeking their co-operation and asking for the names of children desirous of joining in this scheme.

Up to the time of going to press lists have been received from Cyprus, Malta and Nigeria. These lists give not only the names, addresses and ages of the children, but a brief statement of what they are most interested in, what they want to write about and what they are most anxious to hear about from children of similar interests in this country. It is too early to be able to report more than the fact that small cross sections of the names received have been sent to schools scattered over various parts of England and that in many cases English children have already written their first letters. Directors of Education in the United Kingdom are being asked to lend their good offices in the furtherance of this scheme. There is every indication that this facility which the Institute has set out to provide will meet with warm approval.

Specimens of Economic Products of the Empire.—For many years past the Imperial Institute has maintained a service whereby schools are able to acquire, at a nominal cost, specimens of economic

products of the Empire. Head teachers value this service which enables them to set up collections of exhibits of practical use in the teaching of economic geography. Even under war conditions, when it is virtually impossible to secure fresh supplies, the Institute has fortunately been able to continue to meet the requirements of schools. With the practical assistance of the Dominion and Indian High Commissioners in London and of the Colonial Office, steps are now being taken to collect stocks of economic products in the Empire countries overseas for shipment to this country immediately transport become available.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the six months ending May 1944:

DECEMBER

Nil.

JANUARY

E. D. HILL, Senior Inspector of Plants and Produce, Gold Coast.

FEBRUARY

C. S. DEAKIN, M.A., A.M.I.C.E., A.M.I.S.E., Master, Achimota College, Gold Coast.
A. W. HART, Veterinary Officer, Nigeria.
T. HOSKYNS-ABRAHALL, C.M.G., Deputy Chief Secretary, Nigeria.
A. F. R. STODDART, Chief Assistant, Colonial Secretary, Nigeria.

MARCH

C. W. F. BOND, Inspector of Mines, Gold Coast.
J. L. MANDENO, Government Laboratory, New Zealand.

APRIL

R. DAUBNEY, C.M.G., O.B.E., M.Sc., M.R.C.V.S., Director, Veterinary Services, Kenya.
JOHN PAINE, Agricultural Superintendent, Gold Coast.
J. K. ROSS, Assistant Conservator of Forests, Sierra Leone.
C. STAMFIELD HITCHEN, Ph.D., B.Sc., A.R.C.S., Director, Geological Survey, Kenya.

MAY

E. D. BUMPUS, Agricultural Officer, Nigeria.
W. P. GASKELL, Inspector of Mines, Nigeria.
J. H. GISBORNE, Agricultural Officer, Nigeria.
L. J. S. LITTLEJOHN, Agricultural Officer, Cyprus.
J. MCCULLOCH, Veterinary Officer, Nigeria.
MISS A. B. ROBERTSON, Education Officer, Uganda.
F. E. SMITH, Industrial Adviser to Nigerian Government.
DR. R. R. LE G. WORSLEY, Biochemist, East African Agricultural Experimental Station, Amani, Tanganyika Territory.

All Dominion, Indian and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss with the Director and his staff, scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

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PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

VOSSIA CUSPIDATA GRASS FROM NIGERIA FOR PAPER-MAKING

By J. R. FURLONG, Ph.D., A.R.I.C. and H. E. COOMBER, B.Sc.

AMONG post-war possibilities that are receiving consideration in Nigeria is the manufacture of paper pulp and cellulose from the coarse grasses that occur in abundance in that country in common with other tropical African territories.

A number of Nigerian grown grasses have been examined as paper-making materials at the Imperial Institute, and the results have been published in this BULLETIN (1921, 19, 271-282; 1922, 20, 291-292). Another grass that occurs in swamp regions throughout tropical Africa is *Vossia cuspidata* Griff. This is described by Hubbard (*East African Pasture Plants*, Part I, p. 16) as an aquatic perennial grass having submerged or floating stems, as thick as the finger, many-jointed, with numerous fine roots from the joints in the submerged parts, branched, pithy, smooth, hairless, the erect portion up to 1·5 metres high. "It is one of the principal constituents of the Sudd of the Nile and its tributaries and other rivers of tropical Africa. During floods it forms floating islands which often collect and block up the rivers at their bends. In the green state the young growths are fed to cattle and the older stems and leaves are used for making coarse matting."

In Nigeria this grass occurs in the sudd fringing the creeks adjacent to the coast. So far as could be ascertained it had never been tested as a paper-making material, and at the request of the Chief Conservator of Forests a sample was examined at the Imperial Institute.

The material consisted of both stems and leaves, varying in colour from brownish cream to greyish brown. It measured from 51½ in. to 69 in. in length, but the bulk was approximately 59 in. A considerable amount of dust was present.

A representative portion of the sample was cut up by means of a chaff cutter into pieces about 1 to 1½ in. long. It contained 12 per cent. of moisture. Ultimate fibres were prepared and examined microscopically. The dimensions of the fibres were measured by means of a projection microscope with the following results:

	Maximum. *mm.*	Minimum. *mm.*	Average. *mm.*
Length	5·61	0·54	1·64
Width	0·025	0·005	0·013

It will be seen from these figures that *Vossia cuspidata* must be classified as a short-fibred material from the paper-making point of view. Such materials can only give weak types of paper and are normally used as bleached pulps. They find their chief outlet in the form of bleached soda pulps as fillers for incorporation with stronger, longer-fibred materials in the manufacture of printing and writing papers.

Paper-making Trials

The grass, cut into pieces 1 to 1½ in. in length, was cooked in a rotary digester under conditions approximating to those employed commercially for pulping by the soda process. The cooking conditions employed and the yields of pulp obtained (as percentage of moisture-free pulp on the weight of moisture-free grass) are given below:

Digestion No.	Maximum Temperature. °C.	Time at maximum temperature. *Hours.*	Strength of caustic soda. *Per cent.*	Caustic soda, parts per 100 parts of moisture-free grass.	Soda consumption, parts per 100 parts of moisture-free grass.	Yield of moisture-free unbleached pulp on moisture-free grass. *Per cent.*
N 099	135	4	4	20	10·3	48·8
N 100	135	6	4	20	10·9	43·0
N 101	155	5	6	30	17·4	33·3

The grass was found to be fairly readily pulped by the soda process, but some difficulty was experienced in obtaining a pulp completely free from shive. The conditions employed in digestion

N 101 gave, however, a thoroughly well broken down pulp, reasonably free from shive.

The yield obtained under the mildest conditions of cook (N 099) reached the moderately good value of 48·8 per cent. of moisture-free unbleached pulp on the weight of moisture-free material, but the pulp contained a considerable amount of shive, as did that from cook N 100. The more drastic conditions employed in cook N 101, which gave a pulp reasonably free from shive and also easy to bleach, reduced the yield to 33·3 per cent.

Bleaching Trials.—A bleaching test carried out on the pulp from cook N 100 failed to reduce the shive present and showed the conditions of N 100 to be insufficient.

A series of tests was carried out on the pulp obtained from cook N 101 by adding varying ratios of standard bleaching powder (bleaching powder containing 35 per cent. available chlorine) to pulp at 5 per cent. consistency. It was found that the pulp bleached to a good white with 12·5 per cent. standard bleach calculated on the weight of moisture-free pulp, which is equivalent to 4·2 per cent. calculated on the original moisture-free material. This figure was confirmed on a larger scale trial of pulp, which was bleached in order to determine the bleaching yield and also to obtain pulp from which to make standard sheets of bleached paper both before and after beating.

The yield of bleached pulp amounted to 32·6 per cent. of the weight of the moisture-free grass. The quantity of standard bleach required to bleach the pulp, together with the small loss of yield (0.7 per cent. calculated on the moisture-free grass) is very satisfactory from the economic point of view.

Pulp Evaluation.—In order to evaluate the strength and general quality of the pulps obtained in the cooking trials, standard sheets were prepared by means of the British Standard Sheet Machine using the official method described in the Second Report of the Pulp Evaluation Committee of the Paper Makers' Association. The sheets were dried and conditioned overnight at 70° F. and at 65 per cent. relative humidity prior to testing, which was carried out to the Paper Makers' Association official methods. The results of the tests on the standard sheets are given in the following table.

Difficulty was experienced with a considerable amount of siliceous matter which caused unevenness in the sheets. Such siliceous matter can be satisfactorily removed by the equipment available in commercial undertakings.

The pulp evaluation figures show that the present sample of *Vossia cuspidata* grass yields pulp which is rather weak in character. The milder conditions of digestion gave the stronger pulp, but also yielded a higher proportion of shive.

Digestion No.		N 099.	N 100	N 101
Basis weight	*grams/sq. metre*	53·4	60·2	59·7
Thickness . .	*microns*	98	112	107
Bulk . . .	*c.c./gram*	1·84	1·86	1·79
Burst factor .	*grams/cm.*^{2}	25·3	26·2	17·9
Breaking length .	*metres*	4292	4498	3247
Stretch . .	*per cent.*	3·2	3·4	2·7
Tear factor . .	*grams*	58·6	63·1	63·7
Drainage time .	. *secs.*	6·8	8·0	7·7
Remarks		Rather shivy. Buff colour. Well formed sheets somewhat pitted with mineral matter.	Rather shivy. Buff colour. Well formed sheets somewhat pitted with mineral matter.	Almost clean. Buff colour. Well formed sheets somewhat pitted with mineral matter.

In order to evaluate the beating properties of the pulps, pulp from cook N 101 was selected as being the digestion which had produced the most favourable results and therefore most likely to yield a satisfactory product. The pulp was bleached before beating. The tentative method of the Paper Makers' Association was employed. The results obtained are given below. The beating curves were fairly flat and showed that only comparatively small increases in strength can be developed by the beating of the pulp.

Beating Time.		0 mins.	4,500 revs. = 15 mins.	18,000 revs. = 60 mins.
Drainage time at 20° C.	*secs.*	7·4	10·2	14·1
Basis weight	*grams/sq. metre*	56·4	59·6	60·0
Thickness calculated to a basis weight of 60 .	*microns*	107	95	90
Bulk . . .	*c.c./gram*	1·79	1·58	1·49
Burst factor .	. *grams/cm.*^{2}	20·2	24·3	27·2
Breaking length .	*metres*	3272	4367	5101
Stretch . .	*per cent.*	2·4	2·9	3·0
Tear factor		54·3	41·8	40·0

The standard sheets produced under the conditions of bleaching and beating were of good formation, surface and colour, especially those produced from the pulp after beating for 60 minutes. Sheets from the beaten pulp lacked the unevenness which was prominent in the unbeaten sheets and was mainly due to the siliceous matter already referred to in this report.

Conclusions

1. The present sample of *Vossia cuspidata* grass has given a low yield of short-fibred pulp of poor strength.

Such pulp would be suitable as a cheap filler in the furnish of writing and printing papers.

Material of this class would be most satisfactorily pulped by the soda digestion method.

The pulp possesses no attractive properties that would enable it to compete with the commercial pulps already on the market, and it is unlikely that its production in Nigeria for home use or for export would be remunerative.

2. For the production of a paper pulp, fully broken down, digestion with 6 per cent. caustic soda under a pressure of 63 lb./sq. in. was necessary and the yield obtained was 33·3 per cent. on the moisture-free grass.

3. The pulp was easily bleached by a single stage treatment with calcium hypochlorite. It showed no loss of strength and little loss in yield of pulp.

4. Paper pulps prepared from the present sample had an average fibre length of 1·6 mm. and possessed a rather weak unbeaten strength. The beaten pulps gave an opaque paper with a smooth surface but showed comparatively little increase in strength on beating. *Vossia cuspidata* grass would not therefore be suitable for purposes for which high mechanical strength is required, e.g. wrapping paper, but could be used in the manufacture of printing and writing papers.

ARTICLES

Australian Scientific Research Liaison, London

Papers from Australia No. 348

REPORT ON APRICOT-KERNEL OILS[1]

By Miss Baldwin,
Information Section, Council for Scientific and Industrial Research, Australia

Apricot kernels are used for the production of fixed oil, volatile oil, and macaroon or marzipan paste used in confectionery.

The fixed oil is extracted either by pressure or by means of such solvents as carbon disulphide, ether and chloroform. This oil is used in medicine for the preparation of emulsions, in soap-making and for cosmetics, and as a salad oil, mainly for the canning of sardines.

The volatile oil is extracted by the process of maceration and distillation. This used to be done mainly in Grasse (France). This oil may be used in perfume production, in confectionery and, for the sedative action produced by hydrocyanic acid, in medicine.

[1] Published by arrangement with the Secretary, Australian Scientific Research Liaison.

Preparation of the Fixed or Expressed Oil

The apricot pits to be used for the preparation of oils are delivered to a bin, from which they are removed by feeder, going to a revolving, punched plate screen, 20 ft. long by 5 ft. in diameter, with apertures of various sizes. The pits drop into five different sets of crushing rolls that are adjusted so that the pits are broken, with a minimum of damage to the kernels.

The separation of the kernels from the shells is then effected by flotation. The respective densities of these two parts differ by relatively little, and for successful separation by flotation, the concentration of the solution must be adjusted so that its density lies between that of the shells and the whole stones. In an investigation made by the South Australian Department of Chemistry, a 10 per cent. saline bath was found to be satisfactory—the kernels floated and the shells sank. Calcium or magnesium chloride solutions may also be used.

The kernels are removed from one end of the trough by means of a scoop conveyor. To assist separation, the surface of the brine is agitated with beaters, which deflect the floating kernels to the other end of the trough, from which they are conveyed to steam-heated cylinders for drying. A separator of the usual type may also be provided, to free them from unshelled stones and other foreign matter.

The oil is then extracted by expression, first in a continuous conical press, then in a hydraulic press. The purest oil is obtained by expression in the cold, while a second grade can be produced by hot expression. Apricot kernels contain some 40-45 per cent. of fixed oil, and about 90 per cent. of this is recoverable by expression, while practically the whole of the remainder may be extracted by solvents, e.g. ether. As the expressed cake is valuable as a source of volatile oil and as a cattle food, however, the remaining fixed oil is seldom extracted with solvents.

The expressed oil is filtered, neutralised with sodium carbonate, and decolorised with charcoal or fuller's earth.

The kernels of apricots, peaches and nectarines yield fixed oils which are practically identical with the fixed oil obtained from almonds. The commercial "Almond Oil, French" or "Almond Oil, Persic" consists either of pure apricot-kernel oil, or a mixture of this oil with peach-kernel oil or nectarine-kernel oil, or of peach-kernel oil alone. The kernels are frequently mixed before the oil is expressed.

Properties of Apricot-Kernel Oil (Expressed)

The exact character of the fatty acids contained in the oil does not appear to have been determined, but from a comparison of its properties with those of almond oil it would appear that the oil is very similar in composition. The oil is pale yellow in colour and in appearance and taste closely resembles almond oil, but most

observers have agreed that the iodine value is higher. Umney found that 34 samples gave a range of acidity of from 0·6 per cent. to 5·97 per cent. expressed as oleic acid, and he states that the oil with high acidity was very unsatisfactory as regards odour and taste after keeping for a year, in contradistinction to almond oil.

ANALYTICAL CHARACTERS OF APRICOT-KERNEL OIL.

Authority.	S.G. 15°/15°.	Ref. Index 40°.	Iodine Value.	Sap. Value.
Lewkowitsch	0·917—0·920	1·4639—1·4646	107·4—108·7	190·3—198·2
Ross and Race	0·920	1·4639—1·4649	100—106	184—192·4
C. A. Hill	—	—	100—110	—
Southall's Annual Reports	0·916—0·920	1·4609—1·4629*	100·3—105·3	190·1—191·7
Ueno	15°/4° 0·919	1·4650	105·4	188·6 Mongolian kernels
	0·910	1·4586	90·4	182·3 Chinese kernels R.M. = 0·7

* *These figures are for mixed apricot and peach-kernel oils. They are given as* 1·4700–1·4721 *at* 15·5°, *but they seem abnormally low.*

The solidification-point of the oil is at least as low as that of almond oil, whilst the solidification-point of the fatty acids and their melting-point are even lower. The Reichert and Polenske values are similar to almond oil. These properties will serve to distinguish the oil from vegetable oils in general, whilst the somewhat higher iodine value will distinguish the oil from almond oil taken in conjunction with the colour tests now to be described.

Bieber's Test.—Prepare the reagent by mixing together equal weights of water, sulphuric acid and fuming nitric acid. Mix thoroughly 1 c.c. of this reagent with 5 c.c. of the oil and then allow to stand for a few moments at ordinary temperatures. The reagent should be prepared freshly for each test. Almond oil gives no change in colour, apricot-kernel oil gives a pink colour as also do peach-kernel and plum-kernel, although to a lesser extent. The conclusions arrived at must be accepted with a certain amount of reservation, and considerable experience is necessary before anything like certain conclusions can be drawn. The test is practically useless as a colorimetric one for quantitative purposes on account of the different depths of colour produced by oils from different sources. Ross and Race found that the reaction was still given strongly by oils that had been steamed for some hours and even after keeping for a year and bubbling air through the warm oil for three days. Lewkowitsch found that the reaction was given more strongly by a freshly-prepared oil than by an older one; this observer also found that 25 per cent. of apricot-kernel oil in almond oil could not be detected with certainty.

The Kreis Phloroglucinol Test.—This test, proposed by Kreis and modified by Chwolles and Lewkowitsch, consists in shaking the oil with an equal quantity of a mixture of equal volumes of one-tenth per cent. phloroglucinol in ether and nitric acid S.G. 1·45.

Kernel oils give a deep red colouration, whilst some almond oils do not. The fact, however, that some almond oils of undoubted purity give a more or less marked reaction make this test more uncertain than that of Bieber.

Nitric Acid Test.—Nitric acid of S.G. 1·4 on shaking with apricot-kernel oil or other kernel oil assumes a much deeper tint than it does with almond oil where the mixture becomes at most pale yellow.

Nickle's Reaction.—This test, which is recommended by De Negri and Fabris, consists in shaking the oil with calcium hydroxide. Apricot-kernel oil gives a permanent emulsion, whilst most vegetable oils such as almond, olive, etc., remain clear.

Examination for Adulteration.—Apricot-kernel oil, although used as a substitute or an adulterant for almond oil, is itself liable to sophistication. Various seed oils may be used for this purpose, but the practice is not nearly as common as it used to be. The solidifying point and the iodine value are the two important tests.

Uses of Apricot-Kernel Oil (Expressed)

The fixed oil may be used for such purposes as edible flavourings, salad oils or dressings, in cosmetics, and in soap manufacture. The oil may be substituted directly for almond oil, and in U.S.A. it is sometimes used as a substitute for olive oil. Now that olive oil supplies from the Continent are cut off, apricot kernel oil might be of very great value as a substitute for it in the fish canning and textile industries.

Preparation of the Volatile Oil

Volatile apricot kernel oil differs in no sensible degree from oil of bitter almonds. It does not exist as such in the kernel, but results from the hydrolysis of a glucoside, amygdalin, under the influence of the naturally existing ferment emulsin. The fatty oil is obtained from the kernels by expression, and the press-cake crushed and digested with water, when the following reaction ensues:

$$\underset{\text{Amygdalin.}}{C_{20}H_{27}NO_{11}} + 2H_2O = \underset{\text{Benzaldehyde.}}{C_7H_6O} + \underset{\text{Dextrose.}}{2C_6H_{12}O_6} + HCN$$

Amygdalin, taking up two molecules of water, yields benzaldehyde, dextrose, and hydrocyanic acid. Amygdalin is a crystalline body, without any smell of the bitter almond, and does not yield the oil except under the influence of a hydrolytic agent, such as the natural ferment emulsin, or by boiling with dilute acids. The action of the ferment is destroyed by heat or by warm alcohol. Hence if dried and powdered kernels are shaken with boiling water and distilled, no oil is obtained. After the fixed oil has been expressed the press cakes are ground up and soaked for about twenty-four hours in twice their weight of water, to which a quantity

of salt is usually added. The whole is then subjected to distillation. Some trouble, however, is experienced during the process, as the large quantity of albuminoids present causes excessive frothing. To remedy this, the press-cakes are coarsely powdered and at once immersed in boiling water to coagulate the albuminoids and dissolve the amygdalin. The emulsin is, of course, rendered inactive, so that on cooling, a quantity of emulsin of the fresh cake in cold water is added to the previously treated mass. This is allowed to stand, until the emulsin will have converted the whole of the amygdalin into essential oil. The mixture is now distilled. As hydrocyanic acid is a very deadly substance, it is necessary to use great care that none of the vapour is allowed to escape into the air. The distillation is effected by direct steam in most cases. The oil so obtained contains a considerable amount of hydrocyanic acid, the remainder being principally benzaldehyde, C_6H_5COH. The following methods are used to deprive the oil of this poisonous constituent :

The oil is mixed with its own volume of water, and the mixture left on a water-bath with red oxide of mercury, slaked lime, and ferrous chloride, out of contact with the air. After all the prussic acid has been decomposed, the oil is rectified and contains no trace of prussic acid. This process was suggested by Redwood. Liebig used oxide of mercury only. Mackay prefers agitating at intervals for forty-eight hours with a mixture of lime and liquor potassæ. To detect any traces of prussic acid left in the oil, a little of it is dissolved in alcohol, and a few drops of solutions of ferrous sulphate and ferric chloride are added. Slight excess of caustic soda solution is then added, and the precipitate is dissolved by the addition of dilute hydrochloric acid, when a blue colour or precipitate (due to the formation of Prussian blue) appears if any hydrocyanic acid is present. Benzaldehyde is very readily oxidised by the oxygen of the atmosphere to benzoic acid, so that the oil almost invariably contains traces of this body, and if kept in bottles that are not quite full the oxidation becomes more rapid, and crystals of benzoic acid are deposited. This is more especially the case when the oil has been freed from prussic acid. According to Schimmel & Co., 10 per cent. of alcohol added to the oil retards this oxidation.

There appears to be little doubt that the action above indicated for the decomposition of amygdalin does not take place as simply as indicated. Recent researches by Rosenthaler and others indicate that the enzyme is not a single body but a mixture of ferments, and that the system amygdalin-emulsin gives rise to the following series of reactions, which end up with the oil containing benzaldehyde, hydrocyanic acid, and benzaldehyde-cyanhydrin :

(1) Amygdalin, under the influence of amygdalase (one of the ferments) yields mandelonitrile glucoside and glucose.

(2) Mandelonitrile glucoside, under the action of prunase

(another ferment), yields dextro-benzaldehyde-cyanhydrin and glucose.

(3) Dextro-benzaldehyde-cyanhydrin is resolved by d-oxynitrilase into benzaldehyde and hydrocyanic acid.

(4) Benzaldehyde and hydrocyanic acid unite again, under the influence of d-nitrolese, to form dextro-benzaldehyde-cyanhydrin, and also unite, naturally, to form the inactive cyanhydrin.

(5) d-oxynitrilase effects the resolution of the inactive cyanhydrin, giving rise to laevo-benzaldehyde-cyanhydrin.

Properties of the Volatile Oil

The volatile oil is a highly refractive liquid of powerful odour having the following characters:

Specific gravity	1·045 to 1·070
Optical rotation . . .	0° to + 0° 10′
Refractive index . . .	1·5320 to 1·5450

A higher specific gravity indicates a very high amount of hydrocyanic acid, or an abnormal amount of benzaldehyde-cyanhydrin.

The oil is more soluble in water than almost any other essential oil, 1 part dissolving in 300 parts of water at ordinary temperature.

Deprived of its prussic acid the oil has the following characters:

Boiling-point	179°
Specific gravity	1·049 to 1·055
Optical rotation . . .	0° to + 0° 10′
Refractive index . . .	1·5420 to 1·5460

The oil should not contain more than 1 per cent. of benzoic acid as determined by titration with decinormal alkali: higher percentages indicate that the oil is old or has been badly stored, and its odour and perfume value are proportionally lower as the benzoic acid increases.

The constituents of the oil are, as above indicated, benzaldehyde, to which the almond odour is due, hydrocyanic acid, and benzaldehyde-cyanhydrin, $C_6H_5CH(OH)CN$, which, however, is easily decomposed into its components by distillation with water, so that an oil which has been deprived of its hydrocyanic acid directly after distillation may be practically free from benzaldehyde-cyanhydrin.

The principal adulterant of this oil is synthetic benzaldehyde which is almost impossible to detect, unless it contains, as it very frequently does, traces of chlorine, due to impurities formed in the course of manufacture.

Another adulterant, of a much grosser character, is oil of mirbane. This is the cheap almond oil substitute so largely used for perfuming common toilet soaps. Chemically it is nitrobenzene $C_6H_5NO_2$, more or less mixed with impurities, of which the most common is nitrotoluene, which sometimes itself forms the greater part of cheap

nitrobenzene. Indeed, nitrotoluene in any great quantity may be regarded as an adulterant of nitrobenzene. The latter, when pure, is a yellowish liquid of specific gravity at 0° of 1·200, boiling at about 206°, and solidifying at +2° to +3°. It has a coarse almond-like odour, and is poisonous when taken internally, and irritating to the skin when used externally. The cheapness of artificial benzaldehyde should discourage its use in even the very cheap toilet soaps. Nitrotoluene $C_6H_4(CH_3)NO_2$ exists in three isomeric modifications, and nitroxylene $C_6H_3(CH_3)_2NO_2$ in more still. These bodies are found to a considerable extent in the cheaper qualities of nitrobenzene. Consequently it is important that commercial samples should have physical characters in approximate agreement with those above quoted.

To detect the presence of this objectionable substitute in the oil a little of the oil is warmed with iron filings and acetic acid. The nitrobenzene is reduced to aniline $C_6H_5NH_2$, which is distilled off and collected. To the distillate a few drops of solution of ordinary chloride of lime is added. If aniline be present the liquid yields the characteristic violet colour. Pure benzaldehyde combines with sodium bisulphite to form a crystalline compound without the characteristic almond odour. Samples adulterated with nitrobenzene, when shaken with excess of bisulphite of sodium solution, so that the benzaldehyde is entirely combined, then have the characteristic coarse nitrobenzene odour.

Uses of the Volatile Oil

The oil may be used as a flavouring essence in cooking and confectionery, and in the manufacture of perfumes such as heliotrope and muguet. It may also be used as a substitute for the oil of bitter almonds, which has a wide application in the soap industry.

The oil still containing hydrocyanic acid is used as a sedative in medicine.

Use of the Kernel Pulp and Shells

The pulp resulting from the expression and maceration processes is dried and used as cattle fodder. The shells are used as fuel.

Material available in Australia

The following figures, taken from the Production Bulletin, No. 34, 1939-1940, show the annual production of apricots in Australia over the last few years:

Year.	Production in Bushels.
1933-34	1,115,158
1934-35	957,066
1935-36	1,146,047
1936-37	830,280
1937-38	1,334,836
1938-39	986,880
1939-40	1,265,957
Average	1,090,889 bushels
	43,635,560 lb.

Experiments carried out at the Berri Experimental Orchard, South Australia, show that 100 lb. of fresh fruit yield 6·5 lb. of air dry stones or pits.

Figures for the tonnage of fresh fruit used in the production of canned fruit, dried fruit and jam do not seem to be available. However, a considerable proportion of the annual crop is used in this way, and plants for the production of apricot-kernel oils could conveniently be worked as adjuncts to the drying and processing factories. In 1924, for example, 84·5 tons of air-dried pits were available from apricots dried in the Murray district of South Australia (Report No. 6 of the South Australian Advisory Council of Science and Industry).

In experiments carried out by the South Australian Department of Chemistry at that time to determine the yield of oil, etc., from the pits, Moorpark, Royal and Late Riverside apricots were used. The percentage of kernel in the pits was found to be:

	Percentage.
Moorpark	27·96
Royal	27·72
Riverside	29·56
Average	28·41

Various solvents were tried for extracting the oil from the finely sliced kernels, and the best results were obtained with ether. The figures quoted below are the average of at least two closely agreeing determinations:

	Percentage Water.	*Percentage Oil.*
Moorpark	5·67	45·81
Royal	5·57	45·53
Riverside	5·57	48·74
	5·60	46·69

It may be assumed that 90 per cent. of this oil could be expressed.

Corresponding figures for the percentage of volatile oil in the kernels are not available.

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AUSTRALIAN SCIENTIFIC RESEARCH LIAISON, LONDON

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AUSTRALIAN TEA TREE OILS[1]

Prepared by the Council for Scientific and Industrial Research, Australia

AUSTRALIA is rich in myrtaceous shrubs and small trees belonging to such genera as Leptospermum, Melaleuca, Kunzea, Baechea, etc., which collectively are known vernacularly as "Tea Trees."

The various species of tea tree are widely distributed, and occur often in extensive areas. The leaves and terminal branchlets of the great majority of species contain interesting essential oils, which are readily separated by steam distillation.

The Sydney Technological Museum has for many years past been specialising on the essential oil content of Australian indigenous plants. A few years ago the Museum published a special report (*Bulletin No.* 14) dealing with the oils obtainable from three varieties of Australian tea trees, viz., *Melaleuca linariifolia*, *Melaleuca alternifolia*, and *Leptospermum citratum*.

Melaleuca linariifolia

This tree occurs abundantly in the Coast Districts of New South Wales and Queensland. It possesses a paper bark, and not only attains to a great height, being one of our tallest tea trees, but in a luxuriant condition spreads very widely at the top forming a splendid shade tree.

The tree follows watercourses, and flourishes in all swampy situations. The known areas in New South Wales are either not sufficiently large or are too scattered to warrant commercial exploitation, but commercial areas are available in Queensland.

The leaves and terminal branchlets when subjected to steam distillation yield a pale lemon-coloured essential oil to the extent of 1·5 to 2 per cent., according to whether the material is old or young growth. That is to say, 1,000 lb. weight of leaf material will yield from 15 to 20 lb. weight of oil.

The odour of the oil is not easy to describe except perhaps to state that it is very pleasant, with a characteristic myristic or nutmeg odour. The chemical and physical characters of the crude oil are as follows:

Specific gravity	0·8927 to 0·8992
Optical rotation	$+3{\cdot}3°$ to $+6{\cdot}8°$
Refractive index	1·4752 to 1·4780
Ester No.	1·3 to 2·7
Ester No. after acetylation . .	58-82

[1] Published by arrangement with the Secretary, Australian Scientific Research Liaison.

The principal constituents which have so far been identified are of very complex character, several not being common to Australian essential oils, viz.:

α and γ terpinene, cymene, cineol (16-20 per cent.).
Δ' terpinenol-4, serquiterpenes, etc.

These constituents, however, have been shown to possess comparatively high germicidal values when tested against pure carbolic acid using *B. typhosus* as test organism.

Melaleuca alternifolia

This tree bears a superficial resemblance to *Melaleuca linariifolia*, but is quite a distinct botanical entity, although until quite recently it was looked upon as a variety of the latter. It is very common in the North Coast District of New South Wales, being especially abundant in the Clarence and Richmond River Districts, New South Wales. The tree is not so tall as *M. linariifolia*, although it possesses a similar habitat, following the water-courses and flourishing in swampy situations. It has a similar paper bark, but the leaves are much narrower. It appears to extend from the Stroud to the Richmond River. It is more compact than *M. linariifolia*, and some of the areas are so thickly wooded that it is impossible to penetrate the growth except by felling and cutting a path.

This essential oil bears a close resemblance in general chemical and physical characters to that obtained from *M. linariifolia*. 1,000 lb. weight of leaves and terminal branchlets yield about 18 lb. of pale lemon-tinted oil with the same pleasant myristic or nutmeg odour referred to under the other species. Many commercial samples are practically water white. The chemical and physical characters are as follows:

Specific gravity	0·8950 to 0·9050
Optical rotation	+6·8° to + 9·8°
Refractive index	1·4760 to 1·4810
Ester No.	2 to 7
Ester No. after acetylation	80 to 90
Solubility	0·6 to 0·8 vols., 8 per cent. alcohol
Cineol content	under 10 per cent.

The principal constituents which have so far been identified are of very complex character, but identical with those described under *M. linariifolia*, viz.:

d-α-pinene, α and γ terpinene,
cymene (cineol 8 per cent.), Δ' terpinenol-4, sesquiterpenes, etc.

The complex mixture constituting the crude oil has been found to possess a high germicidal value when tested against pure carbolic acid, using *B. typhosus* as test organism, being from eleven to thirteen times more powerful or effective in destroying typhoid germs than carbolic acid under similar conditions. The pleasant

odour, together with the high germicidal efficiency, and at the same time non-poisonous properties, have resulted in industrial application of this oil in germicides, solvents, etc., as well as refined uses in medicine and therapeutics.

The standardised oil is of great value in surgical work. This is chiefly due to its power of penetrating pus, and of mixing with it in a manner which causes it to slough off, leaving a healthy surface. Some idea of the wide field of usefulness in which this oil has found application can be gauged from the following conditions which have responded to treatment: perionychia, empyema, gynaecological conditions, skin conditions (epidermophyton infection, psoriasis), impetigo contagiosum, pediculosis, ringworm, tinea (albuginea), throat and mouth conditions (acute nasopharyngitis, catarrh, thrush, and "aphthous" stomatitis, tonsilitis and ulcers of the mouth, sore throat).

Commercial Exploitation of the Melaleuca Oils

Formerly almost all the tea tree oil produced in Australia was exported. Since the war, however, it has been used in increasing amounts in Australia, and at present, owing to manpower shortage, the supply is insufficient to meet the demand. Export of tea tree oil to any country was recently prohibited.

The present rate of production is 1,600 to 2,000 gallons per annum. 90 per cent. of this is produced by Messrs. Australian Essential Oils Ltd., who put the oil of *M. alternifolia* on the market some years ago under the proprietary names of "Ti-Trol" (the oil), and "Melasol" (the water soluble form).

The oil of *M. alternifolia* is being used for surgical and dental purposes, and that of *M. linariifolia* for soaps and perfumery and industrial purposes.

The supply of raw material for the production of the oils is practically inexhaustible. The Eucalypts are remarkable for their reproductive properties after cutting back, but these Melaleucas, or paper bark trees, are unique and superior in this connection. The trees, after reduction to mere stumps, at once take on a new lease of life and throw out succulent shoots, or suckers, which in a remarkably short time form fine bunches of healthy foliage rich in oil on the heads of the stumps. After only a few months this new growth gives a unique appearance to the otherwise barren wood. Cutting and gathering this new foliage is a simpler and more expeditious operation than that of the first collection. The operation can be repeated over a great number of years, for it appears to be quite impossible to destroy the trees except by grubbing out the roots.

Leptospermum citratum

Leptospermum citratum is a very attractive lemon-scented tea tree found growing sparsely at Copmanhurst, and at Springbrook

and Palmwood, Queensland. The leaves and terminal branchlets yield a very pleasant and valuable essential oil possessing a strong pleasant lemon odour, modified with that of citronellal. 1,000 lb. weight of plant material yields from 10 lb. to 15 lb. of a pale lemon coloured oil containing 85 per cent. of citral and citronellal, the former constituting 50 per cent.

The chemical and physical characters of the crude oil are as follows:

Specific gravity, 15/15°	0·8792 to 0·8856
Optical rotation	+ 3·5° to + 5°
Refractive index at 20° C.	1·4688 to 1·4757
Solubility in 70 per cent. alcohol	1 to 1·2 vols.
Total aldehydes (citral and citronellal)	75-85 per cent.

The aldehydes consist principally of citral (45 to 50 per cent.) and citronellal (35 per cent.). The balance of the oil contains the alcohols geraniol and citronellol and their formic and acetic acid esters, sesquiterpenes and sesquiterpene alcohols, and less than 1 per cent. of eugenol.

Commercial Exploitation of Leptospermum citratum oil

At present there is insufficient raw material to meet commercial requirements. 80 gallons per annum is being produced in Australia and is sold for £10 per gallon. The trees are sparsely distributed on rocky ranges. There are a few small experimental plantations not yet in production.

Some years ago seed of *L. citratum* was sent from Australia to Kenya, and plantations were established there.[1] These are the first commercial plantations in the British Empire. Small shipments of oil from these plantations are arriving in Australia every few months. The price is considerably lower than the present selling price of oil produced in Australia.

Most of the oil is sent to Melbourne and Perth, where it is used for the manufacture of citral, citronellal, and citronellol. Citral prepared from the crude oil of *Leptospermum citratum* is free from citronellal and is superior to citral prepared from any other source with the possible exception of *Backhousia citriodora* oil.

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[1] An account of the work in Kenya and a report on a sample of *L. citratum* oil produced there, were published in this BULLETIN, 1942, **40**, 1-5.

NOTES

Retirement of Mr. H. J. Jeffery.—The retirement of Mr. H. J. Jeffery, A.R.C.S., F.L.S., on attaining the age of 60 after over 33 years' service means a serious loss to the Imperial Institute as well as to many outside it with whom his work brought him into frequent contact.

Before coming to the Institute in 1911 Mr. Jeffery had had a training and experience which laid the foundation for the readiness and enthusiasm with which he was subsequently to deal with a wide range of subjects. Following three years at the Royal Botanic Society's School of Gardening he proceeded in 1904, with a National Scholarship in Geology, to the Royal College of Science, where he took the A.R.C.S. Diploma in 1907 with a first class in Botany. From 1907 to 1911 he was Lecturer in Botany at the Pharmaceutical Society's School of Pharmacy and the South-Western Polytechnic.

He joined the staff of the Institute as Special Assistant to Dr. T. A. Henry, then Superintendent of the Laboratories, being engaged primarily in the production of Imperial Institute publications. Later he was for a time in charge of the Library, and when the Institute was reorganised in 1926 he took his place in the Plant and Animal Products Intelligence Section, of which he became Vice-Principal in 1936.

During the whole of his time at the Institute in addition to his other offices he was concerned with the production of the BULLETIN, first as sub-editor and in later years as general editor, a task involving the preparation for publication of the reports on investigations carried out in the Laboratories, and also the compilation of numerous technical articles.

Apart from this work he was part author with J. F. Bevis of *British Plants: Their Ecology and Biology.*

He will be remembered by the many people who came to the Institute in search of advice, for the unstinted trouble that he took in dealing with their questions, and for his rare capacity for solving difficult problems and extracting information from unlikely sources. His never-failing readiness to help, and his capacity for understanding other people's points of view, played a great part in the position that he held in the esteem and affection of his colleagues.

Licuri Wax.—Some seven or eight years ago a palm wax of Brazilian origin appeared on the market as a competitor of carnauba wax, under a variety of names such as Ouricuri, Urucury, and Uricuri. There was some doubt as to its botanical origin, and it appears that when it was first examined by the Brazilian Ministry of Agriculture it was believed to have been obtained from the palm *Attalea excelsa* Mart., though by other authorities it was referred to *Cocos coronata* Mart. (synonym *Syagrus coronata* Mart.). The latter

attribution has now been accepted as correct, and to avoid perpetuating any confusion it is proposed by the Brazilian authorities that the wax should be known by another native name, Licuri.

A number of accounts of the Licuri palm and its wax have appeared in various publications, the most comprehensive that have been received at the Imperial Institute being an article entitled "A cêra de Licuri na Baía," by G. Bondar, in the Brazilian *Revista de Chimica Industrial*, 1941, **10**, 88-90, 119-122, 154-157, and *Bulletin No.* 11 (1942) of the Instituto Central de Fomento Economico da Bahia, by the same author, entitled "As Cêras no Brasil e o Licuri, *Cocos coronata* Mart., na Bahia."

The licuri palm is very hardy and resistant to drought; it will grow in places where few if any other plants can live, and fails to adapt itself only in marshy soils or in situations permanently moist with stagnant water.

The tree is found growing wild over at least half the state of Bahia, that is to say over an area of more than 25,000,000 hectares, in densities from 100 to 1,000 trees per hectare. Assuming an average of 200 trees per hectare, we have a figure of five thousand million trees in Bahia alone.

The wax occurs on the surface of the leaves. It is reckoned that at each harvesting a tree yields 150-300 grams of wax powder, and each tree can in general be harvested three or four times a year, as successive leaves come to maturity, so that the possible yield may be estimated as ½-1 kilo per tree per annum. Actually, in 1941 rather more than 2,300 metric tons of licuri wax were exported from Bahia.

The wax adheres to the leaves more closely than is the case with carnauba wax, and in order to separate it a scraping process is necessary. This results in the admixture of portions of leaf with the wax powder. Formerly the purification of the wax was effected by comparatively simple methods, but since 1940 it has been centralised and improved equipment has been adopted. The process consists essentially of three operations; first, removing the grosser impurities by means of sieves; second, melting the powder at a temperature of 90° C. for a prescribed length of time and filtering the liquid; third, solidifying the melted wax in moulds to produce cakes of convenient size.

The analytical characteristics of licuri wax vary somewhat according to different investigators. The following comparative figures for licuri and carnauba waxes have been determined by the Institute of Chemistry of the Brazilian Ministry of Agriculture:

	Licuri wax.	Carnauba wax.
Melting point . . .	84·8° C.	85° C.
Saponification value . .	78·8	79
Iodine value . . .	8·6	10
Ester value . . .	73·5	75
Acid value . . .	5·5	4
Total fatty acids . .	47·54	47·89
Solubility . . .	Both are soluble in hot alcohol and in ether.	

Licuri wax is described as having a slightly orange colour. Its specific gravity at 15° C., according to M. Silva (*Inst. Nacional de Tecnologia, Rio de Janeiro, Bulletin No.* 67, 1940) is 1·010, compared with a recorded figure of 0·999 for carnauba wax.

It is evident from the figures quoted above that the two waxes closely resemble one another. Licuri wax can be used as a cheaper substitute for carnauba wax, for the same purposes, and it is claimed that it has some actual advantages, for example, a greater solubility in the common commercial solvents.

In spite of the close resemblance between the two waxes it is stated that they can be readily distinguished in the laboratory. In powder form, as separated from the leaves, the two present different appearances under the microscope; they are also distinguished by a simple chemical test: a solution obtained by violently shaking 3 grams of the sample in 10 cc. of a 10-20 per cent. solution of caustic soda has a yellowish-orange colour in the case of licuri wax, whereas carnauba wax gives no coloration.

The wax is not the only useful product of the licuri tree. The kernels of the nuts yield 57-62 per cent. of an oil closely resembling coconut oil in taste and odour. The fruit furnishes food both for men and animals. In times of drought an edible farinaceous product is prepared from the interior of the trunk. The leaves serve for making hats, sacking, mats and ropes, as well as for feeding cattle.

The vast potentialities of the licuri palm present a number of problems to the Brazilian government, including regeneration and the prevention of destruction, improvement by cultivation and selection, and the utilisation to the best advantage of the very large quantities of leaves remaining after the separation of the wax.

F. F.

New Oil Palm Research Station in Nigeria.—The oil palm (*Elaeis guineensis* Jacq.), a chief source of agricultural wealth in West Africa from Sierra Leone to Angola, is of particular importance to Nigeria. As regards that Colony it has been stated recently that the export value of oil palm products is about £6,000,000 in a normal year, apart from the extensive use of palm oil as a local foodstuff. The Nigerian Agricultural Department has for many years devoted considerable attention to this crop.

In 1939-40 the authorities provided funds and land for the development of a main Oil Palm Research Station, near Benin. Four annual reports have now been received covering work at this station, and elsewhere in the Colony, during the years 1939-40 to 1942-43. Those for the first three years appear under the names of Mr. A. F. W. Sheffield, Agricultural Officer, and Messrs. F. W. Toovey and G. K. G. Campbell, Botanists. The fourth and most recent is signed by Mr. Toovey. Preceded by an introduction and completed by statistical appendices, the 1942-43 report—Oil Palm Research Station, Nigeria: Fourth Annual Report, 1942-43, 36 pp.

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mimeographed (Department of Agriculture, Nigeria, 1943)—is divided into three parts: Development of the Main Station; Cultural Experiments (including experiments at other stations); and Selection, Breeding and Botanical Investigations. All the reports have so far appeared in mimeographed form, and in present circumstances may have had no very wide circulation; thus a note of this recent research may be of general interest.

The main station extends to an area of some 4,000 acres, laid out in 100 acre experimental blocks, and is situated in forest country in Benin Province. It is on the Benin sands soil formation, and the average rainfall (three years) is given as 74.70 in. Rainfall peaks of 12-13 in. occur in the months of June, July and September; December, January and February are dry. Buildings appear to be still of a temporary character, but by the end of 1943 over 500 acres of progeny trials and cultural experiments were due to be established, planting having begun in 1939.

The station is concerned with the solution of both long and short range problems, though at the present stage there is inevitably less to report concerning the former.

In the third annual report (1941-42, page 2), the work of the station is described as falling under three headings:

(i) To determine the most efficient means of cultivating oil palms, the problem viewed principally from the point of view of the peasant farmer, not of the large estate.

(ii) To select and breed for improved seed and to arrange for its production on a large scale.

(iii) To conduct research into the best methods of extracting palm oil and kernels from the fruit.

It is, moreover, observed that "the purpose of the station is to conduct research for the betterment of the oil palm industry of British West Africa, . . . also to ensure that oil palm products required for export and internal consumption shall be grown with such efficiency as to lead to the most economic utilisation of land." The latter object is regarded as of particular importance in view of the ultimate possibility of producing from one acre the same quantity of palm products as can be provided at the present time by two or three acres of wild palms, with consequent relief to the overcrowded areas in West Africa where pressure on land is a serious factor.

The resources for oil palm investigation and research at the main station are supplemented by palm plots at agricultural experiment stations, by areas such as the Aba palm plantation and the Umunebo-Ufuma "natural palm grove," and by the work that is undertaken on the Ndian Oil Palm Estate in co-operation with the United Africa Company. For instance, the area of palms described as "under control" at the end of March 1943, is given as 1,412 acres, with 30,560 palms individually recorded for yield.

Seed for Farmers.—One of the most important lines of work covered in these reports is the provision of seed to raise the palms required for farmers' plots. In 1942-43 some 423,000 seeds were produced by controlled pollination of thick-shelled × thick-shelled and thick-shelled × thin-shelled palms. The decision has been made not to issue for the time being plants raised from "pure" thin-shelled seed. This is on account of (1) the superior bunch yielding capability so far shown by the best Nigerian thick-shelled palms compared to the best thin-shelled palms; (2) the sterility factor with thin-shelled palms: in the case of a small farmer's plot about a third of the palms might prove to be sterile; and (3) the lower yield of kernels which are an important product to the peasant.

Seed Germination.—This at one time presented a problem which now seems to have been solved. In 1939, of 48,000 seed sown in the Ibadan germinators, 71 per cent. had germinated at the end of six months and 80 per cent. after nine months. A description of the Nigerian oil palm seed germinator has been published (E. H. G. Smith and F. W. Toovey, *Trop. Agric., Trin.*, 1938, **15**, No. 2, 39-40).

Storage of Oil Palm Seed.—It appears from the result of a recent experiment that oil palm seed may be stored for up to twelve months without loss of viability. This fact, if fully established, will facilitate seed exchanges, and have cultural advantages in permitting sowing to be deferred for some months where such a course may be convenient.

Transplanting Oil Palm Seedlings.—In an experiment the best treatment was found to be no root pruning, severe leaf pruning, and planting sites holed. In removing seedlings from the nursery it was found to be of the greatest importance to preserve the long and fibrous brown roots; the young white roots are unimportant unless the older roots have been damaged. The leaves should be pruned right back to the central "spear" before transplanting. Such severe leaf pruning is reported not only to facilitate transportation but to give a better grown plant by the end of the first year. Holing, even when the holes are quite small (2 ft. cube), is stated to reduce transplanting losses by nearly 25 per cent. and gives much better developed plants at the end of the first year.

"Yellowing Disease" of the Oil Palm.—What is locally known as "yellowing disease," described as a physiological disorder causing much stunting and distortion of the oil palm, and occurring chiefly in the Eastern Provinces, has been successfully treated by heavy applications of wood ashes (or incinerator ash). Experimental palms treated with sulphate of potash and with a complete NPK mixture have also shown recovery. Indications appear to be that applications of potash will lead to successful treatment though on present knowledge of the disorder the possibility of a minor element being involved cannot yet be excluded.

Cultural Experiments.—Much space is devoted in these reports to a number of important cultural and manurial experiments that are in progress. An urgent problem at the moment is stated to be the falling off in yield that has occurred on most of the older plots of planted palms on the departmental experimental farms, which has given rise to considerable misgivings in connection with the campaign for planted oil palms. Among trials recently laid down is the interesting "spacing-cum-grazing-cum-intercropping" experiment which "sets out to determine not only the optimum spacing for oil palms grown as a sole crop, but also the most economic form of spacing for farmers who wish to graze cattle or grow food crops between their palms." This comprehensive long-term experiment, it is worth recording, was designed with the active assistance of the statistical experts at Rothamsted Experimental Station.

Oil Palm Breeding.—On this important question there is as yet little to report "except the planting up of large-scale progeny trials, and no great advance in our knowledge is likely until the large areas planted during the last few years come into bearing." The scope of the work is wide: "all known types and forms are being studied in the oil palm selection programme as it is felt that only by investigating the complete range of variation exhibited by the crop can the greatest progress be made towards the production of improved strains." Much attention is being paid to investigating the inheritance of thin-shelled forms, with particular reference to the inheritance of sterility. Certain indications are already appearing. For instance, it seems that the "number of bunches" is an inherited character, and will be an important factor in selection. In palms so far under observation bunch yields of thick-shelled palms generally exceed those of thin-shelled trees. Another tentative conclusion is that the early yields of young planted palms are not of much interest as an indication of later yields. Descriptions of the simple tentative Nigerian oil palm classification into "types" and "forms" have been published by E. H. G. Smith, see this BULLETIN (1935, **33**, 371-2) and by Smith and Toovey (*loc. cit.*, 33-5).

In all, as this brief summary indicates, there is already much information of considerable value appearing in these reports. The general impression gained by their perusal is that oil palm research is proceeding in Nigeria on sound lines, and in due course great advantages should accrue to the West African oil palm industry from the careful research and investigations already shown to be in progress.

E. H. G. S.

The Vegetable Tanning Materials of Katanga.—The analysis of a number of materials collected in Katanga, Belgian Congo, as likely to be of value as tanning materials has been carried out by Dr. L. Thuriaux, at the chemical laboratory of the Comité Spécial du

Katanga. The results, originally published in the *Bulletin Agricole du Congo Belge*, 1942, **33**, 245-254, have been issued as a reprint.

It was found that of the naturally occurring trees, four materials derived therefrom contained over 16 per cent. of tannin expressed on dry matter. These were the barks of *Brachystegia mpalensis*, *Pterocarpus delevoyi*, *Combretum album*, and *Terminalia* sp. (Bubu). The testing of extracts for the production of leather has been delayed by the war.

In addition to the above, the bark, leaves, pods or roots of the following were examined. *Acacia* spp.; *Bauhinia* sp.; *Swartzia* sp.; *Aleurites fordii*; *Hymenocardia* sp.; *Polygonum* spp.; *Protea* sp.; *Albizzia* sp.; and *Eucalyptus* spp. Of samples from cultivated trees, the resin of *E. citriodora* contained 48 per cent., and the leaves of *E. microcorys* 21 per cent. of tannin on air-dry material.

J. R. F.

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Plasticising Lac Films from Aqueous Solutions. Part 1. By B. S. Gidvani. *Tech. Pap. No.* 24, *Lond. Shellac Res. Bur.* Pp. 19, 8½ × 5½. (London: Shellac Research Bureau, 1944.)

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Gutta Percha and Balata, with particular reference to their use in Submarine Cable Manufacture. By J. N. Dean. *J. Roy. Soc. Arts*, 1944, **92**, No. 4668, 368-386.

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CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 27

(April to June 1944)

Compiled by MISS R. M. JOHNSON.

With the collaboration of the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Report of the Administrator of Agricultural Research, United States Department of Agriculture, 1943. Includes the Report of the Chief of the Bureau of Entomology and Plant Quarantine in which references are made to the following: the use of nicotine dust for suppressing the pear psylla

(p. 126): addition of cube resins to low concentrations of oil emulsion increased their efficacy against the scale insect *Parlatoria chinensis* (p. 127): single treatment of the ears with pyrethrum extract in mineral oil will protect sweet corn grown for seed against the corn earworm (p. 131): derris sprays and dual-fixed nicotine dust reduced the borer infestation of early sweet corn (p. 133): efforts to extend the efficacy of rotenone and pyrethrum by the addition of nicotine and/or sulphur (p. 135): pyrethrum controls the potato flea beetle but not the tobacco flea beetle (p. 136): addition of nicotine to calcium arsenate applications effective in preventing an increase in cotton aphids under certain conditions (p. 139): aqueous spray containing sodium fluoride and nicotine sulphate effective against disease-carrying ticks on camp sites (p. 144): nicotine sulphate and "lethane 60" very efficacious against cattle lice when used together and fairly so when employed alone (p. 145): toxicity tests for the improvement of aerosols containing pyrethrum (p. 147): extracts of *Willardia mexicana*, *Ryania speciosa* and *Amorpha fruticosa* tested and proved promising against house flies: materials found to increase the effectiveness of pyrethrum dusts against leaf-feeding larvae (p. 148): investigations on *Amorpha fruticosa* and *Pachyrrhizus erosus* failed to confirm presence of rotenone (p. 149).

Entomological Problems. *Rep. Hawaii Agric. Exp. Sta.*, 1941-42. (*R.A.E.*, 1944, **32**, A, Pt. 4, 136-138.) Nicotine sulphate and diesel-oil emulsion effective against *Bedellia orchilella* on sweet potatoes; cowpeas protected from the Jassid by Bordeaux mixture and nicotine sulphate or pyrethrum powder and wettable sulphur; a commercial pyrethrum and rotenone spray gave the highest initial mortality of Jassid but had little residual effect: *Pycnoderes quadrimaculatus* on bush beans controlled by sulphur dusts containing rotenone or dust of lime and nicotine: *Hellula undalis* a pest of cabbage controlled by a rotenone dust: pyrethrum dusts most effective on pests of beets.

Insecticides and Equipment for Controlling Insects on Fruits and Vegetables. By N. F. Howard, C. A. Weigel, C. M. Smith and L. F. Steiner. *Misc. Publ. No.* 526, *U.S. Dep. Agric.*, 1943. Cube, derris, hellebore, nicotine and pyrethrum are among the products dealt with.

Insect Pests of Cabbages and Cauliflowers. By J. H. Smith. *Queensld. Agric. J.*, 1943, **57**, Pt. 4, 217-225. Refers to the use of derris or nicotine for control of the cabbage moth, derris against the cluster caterpillar and corn earworm, nicotine or derris against aphids.

Experiments with Insecticides against the Red-legged Earth Mite (*Halotydens destructor* Tucker). By K. R. Norris. *Bull. No.* 171, *Coun. Sci. Indust. Res. Aust.*, 1943. Of the sprays recommended those incorporating nicotine sulphate were outstanding, whilst the rotenone-white oil emulsion was also highly toxic.

Strawberry Insects and their Control in Missouri. By W. W. Smith. *Bull. No.* 463, *Mo. Agric. Exp. Sta.*, 1943. (*R.A.E.*, 1944, **32**, A, Pt. 3, 96.) *Ancylis comptana* controlled fairly satisfactorily by derris or pyrethrum dusts or nicotine spray.

Bull. No. 472, *Connecticut Agric. Exp. Sta.*, 1942. Report of the State Entomologist. (*R.A.E.*, 1944, **32**, A, Pt. 3, 93-94.) References to the control of the squash vine borer *Melittia satyriniformis* by a rotenone dust and the effect of a derris-pyrethrum dust on the Mexican bean beetle.

Winter Control of Cattle Lice. By J. A. Munro and H. S. Telford. *Bull. No.* 324, *N. Dakota Agric. Exp. Sta.*, 1943. (*R.A.E.*, 1944, **32**, B, Pt. 5, 100.) As rotenone and pyrethrum are scarce tests were made of a number of compounds including Sabadilla seed and nicotine: a sulphur dust containing not more than 1 per cent. nicotine proved the most satisfactory.

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Insecticidal Compositions. U.S. Pat. No. 2,286,222. Pyrethrum or rotenone used together with an organic thiocyanate and a synthetic ether compound. *Pharm. Absts.*, 1944, **10,** No. 2, 36, in *J. Amer. Pharm. Assoc., Sci. Ed.*, 1944, **33,** No. 2.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Toxicity of Nicotine Aerosols to the Green Peach Aphid under Greenhouse Conditions. By F. F. Smith and L. D. Goodhue. *J. Econ. Ent.*, 1943, **36,** No. 6, 911-914.

Nya ron angaende blodlusen. By C. Castberg. *Växtskyddsnotiser*, 1941, No. 6, 86-90. (*Hort. Absts.*, 1944, **14,** No. 1, 22.) Nicotine gave good results against woolly aphis especially against small larvae on young growth.

Recovery of Nicotine. U.S. Pat. No. 2,293,954. *Brit. Chem. and Physiol. Absts.*, 1944, *BIII*, 34.

Nicotine Insecticides and Poisons Act. *Chem. Tr. J.*, 1944, **114,** No. 2,968, 366. Exemption of agricultural and horticultural insecticides consisting of nicotine dusts containing not more nicotine than provided by Section 18 (2) of The Poisons (Amendment) Rules, 1944.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Economic Plants of Interest to the Americas. Rotenone. By F. J. Hermann. *Publ. U.S. Dep. Agric.*, 1943. General article on sources of rotenone, cultivation technique and methods of harvesting etc.

The Eradication of Sheep Ticks, *Melophagus ovinus*, by one Dipping in dilute Derris-water or Cube-water Dips. By N. G. Cobbett and C. E. Smith. *J. Amer. Vet. Med. Assoc.*, 1943, **103,** No. 796, 6-10. (*R.A.E.*, 1944, **32,** B, Pt. 4, 65.)

Biology and Control of Common Blister Beetles in Arkansas. By W. R. Horsfall. *Bull. No.* 436, *Arkansas Exp. Sta.*, 1943. (*Exp. Sta. Rec.*, 1944, **90,** No. 2, 226.) Rotenone satisfactory.

Control of the Apple Maggot with Rotenone Dusts. By P. Garman. *Bull. No.* 474, *Connect. Agric. Exp. Sta.*, 1943. (*Amer. Chem. Absts.*, 1944, **38,** No. 7, 1601.)

Some Color Tests for Rotenone not Specific. By H. L. Haller. *Industr. Engng. Chem., Anal. Ed.*, 1944, **16,** No. 4, 277. Durham and Gross-Smith-Goodhue tests when positive do not necessarily indicate presence of rotenoids in plants other than derris, lonchocarpus and teprosis species.

Compositions for the Control of Pests, such as Red Spider on Bean Plants.

U.S. Pat. No. 2,327,105. Rotenone in a suitable medium. *Amer. Chem. Absts.*, 1944, **38**, No. 3, 616.

Insecticidal Rotenone Products suitable for Use in Powdered Form on Foliage. U.S. Pat. No. 2,326,297. *Amer. Chem. Absts.*, 1944, **38**, No. 3, 616.

Water-soluble Rotenone-containing Antiparasiticides. German Pat. No. 730,934. *Amer. Chem. Absts.*, 1944, **38**, No. 3, 616.

The Stability of Rotenone in a Phenol-Oil Solution. By G. G. Robinson. *Bull. Ent. Res.*, 1944, **35**, Pt. 1, 1-2.

Derris

Summary of Recent Investigations carried out in the Chemical Laboratory [Department of Agriculture, Fiji]. By W. J. Blackie. *Agric. J. Fiji*, 1944, **15**, No. 1, 19-20. Results of tests on the rotenone of derris (Amani strain).

Insecticidal Treatment of Market Sweet Corn with High-clearance Boom Equipment for Control of the European Corn Borer. By D. D. Questel. *J. Econ. Ent.*, 1943, **36**, No. 6, 893-896. Derris used.

Derris Work. *Fmr. and Stk. Breed.*, 1944, **58**, No. 2847, 688. Refers to the new product of secret formula known as Compound 666 which is designed to take the place of derris.

Cube

Experiments for Field Control of the Narcissus Bulb Fly. By R. Schopp, P. M. Eide and C. F. Doucette. *J. Econ. Ent.*, 1943, **36**, No. 6, 864-867. Tests with ground cube root indicated that this material probably has no practical effectiveness.

Others

Home-grown Rotenone Source is Found. By H. I. Featherly. *South. Seedsmen*, 1942, **5**, No. 12, 11. (*Exp. Sta. Rec.*, 1944, **90**, No. 2, 219.) Rotenone found in the fruit of *Amorpha fruticosa*.

Occurrence of Rotenone and Related Substances in the Seed of the Berebere Tree. A Procedure for the Separation of Deguelin and Tephrosin. By E. P. Clark. *J. Amer. Chem. Soc.*, 1943, **65**, 27.

Toxicity Studies on Some Chinese Plants. By C. S. Lee and R. Hansberry. *J. Econ. Ent.*, 1943, **36**, No. 6, 915-921. Tests with 35 species of Chinese plants reputed to have insecticidal, piscicidal or medicinal value were made using silkworms, bean beetle larvae or bean aphids. *Pachyrrhizus erosus* Urban seemed to offer the most promise of being of commercial value. *Millettia pachycarpa* Benth. worthy of experimental propagation for insecticidal purposes.

PYRETHRIN-CONTAINING MATERIALS

The Relative Effectiveness of Some Corn Earworm Control Measures in Sweet Corn. By R. H. Davidson. *J. Econ. Ent.*, 1943, **36**, No. 6, 938. Styrene dibromide in mineral more effective than pyrethrum.

The Use of a Plaster Substratum for Testing Pyrethrum-oil Films against *Ornithodorus moubata* Murray. By G. G. Robinson. *Bull. Ent. Res.*, 1943, **34**, Pt. 4, 269-277. (*R.A.E.*, 1944, **32**, B, Pt. 3, 46.)

Pyrethrum Flowers and the Pyrethrins. By T. F. West. *J. Sci. Industr. Res. India*, 1943, **2**, No. 1, 7-10.

Aerosol Insecticides. *Chem. Tr. J.*, 1944, **114**, No. 2973, 509. Pyrethrum in aerosol-insecticides being replaced for some purposes by "DDT" (dichlorodiphenyltrichlorethane).

Activation of Pyrethrins in Fly Sprays. By W. A. L. David and P. Bracey. *Nature*, 1944, **153**, No. 3889, 594.

Mothproofing Textiles. *Mfg. Chem.*, 1944, **15**, Pt. 5, 183. Trichlorobenzyl phenyl ether in alcohol or acetone solution used as a moth proofing agent and mixed with pyrethrum as an insecticide.

Absorption Spectra and the Structure of Pyrethrins I and II. Part II. By A. E. Gillam and T. F. West. *J. Chem. Soc. Lond.*, 1944, February, 49-51.

Additive to Pyrethrum. Canad. Pat. No. 415,905. *Soap*, 1944, **20**, No. 3, 115. Fenchyl chloroacetate enhances the toxicity of pyrethrum.

The Alfalfa Plant Bug *Adelphocoris lineolatus* and other Miridae (Hemiptera) in relation to Alfalfa Seed Production in Minnesota. By J. H. Hughes. *Tech. Bull. No.* 161, *Minnesota Exp. Sta.*, 1943. (*Exp. Sta. Rec.*, 1944, **90**, No. 4, 506.) Tests with pyrocide dust and sulphur on mirids attacking alfalfa indicated that pyrethrum was more effective than sulphur, but seed yields in treated plots were not increased over non-treated plots.

A Note on Pyrethrum Cultivation. Issued by the Forest Research Institute, Dehra Dun. *Indian For.*, 1944, **70**, No. 3, 77-79.

Pyrethrum Cultivation in French Morocco. *Public Ledger*, 1944, No. 33,497, 1. Efforts being made to interest farmers in the crop.

Pyrethrum Cultivation in India. *J. Sci. Industr. Res. India*, 1943, **2**, No. 1, 55. Brief note only.

Pyrethrum Cultivation in Kenya. By R. S. Ball. *Bull. Imp. Inst.*, 1944, **42**, No. 1, 13-24.

The Pyrethrum Fields of Kenya. *Country Life*, 1944, **95**, No. 2468, 769. A brief account of production.

Tanganyika Released Pyrethrum for Local Manufacture. *Public Ledger*, 1944, No. 34,497, 1. Fourth grade flowers released for manufacture of anti-mosquito spray.

Incremento da produçao de piretro no R. G. do Sul. *Ion, Madrid*, 1943, **12**, No. 139, 31. Increased production of pyrethrum in Rio Grande do Sul, Brazil.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Insecticides from the Castor Plant. *Chem. Tr. J.*, 1944, **114**, No. 2,972, 481. A new insecticide marketed in the U.S. under the name of "Spra Kast" consists of extractives from the leaves and other parts of the castor plant.

The Alkaloids of American Hellebore and their Toxicity to the American Cockroach. By E. J. Seiferle, I. B. Johns and C. H. Richardson. *Pests*, 1943, **11**, No. 7, 8-11, 28-32. (*Exp. Sta. Rec.*, 1944, **90**, No. 1, 76. Title only.)

Fish Poisons from *Ichthyomethia piscipula* L. [*Piscidia erythrina*]. I. By A. Russell and E. A. Kaczka. *J. Amer. Chem. Soc.*, 1944, **66**, No. 4, 548-550. Extraction of the root bark or root wood of Jamaica dogwood with petroleum ether gives a mixture of crystalline materials very toxic to goldfish: two pure compounds have been isolated, rotenone and a new compound ichthynone: the latter kills goldfish at a concentration of one part in a million.

Insecticidal Tests with [the Fruits of] *Phellodendron amurense*. Extractive and Several of its Fractions. By W. K. Sullivan, M. S. Schechter and H. L. Haller. *J. Econ. Ent.*, 1943, **36**, No. 6, 937-938.

Effect of California Buckeye (*Aesculus californicus*) on Ants. By A. C. Davis. *J. Econ. Ent.*, 1943, **36**, No. 5, 800.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

TEA UNDER INTERNATIONAL REGULATION. By V. D. Wickizer. Pp. vi + 198, 9 × 6. Food Research Institute, Commodity Policy Studies No. 4. (California: Food Research Institute, Stanford University, 1944.) Price $2.50.

Apart from the unique position which tea occupies in every home in the United Kingdom, the commodity is an important British commercial interest. This country is easily the chief importer, and the centre of the world's tea trade. Much British capital is invested in the tea growing estates overseas. Altogether, Empire countries provided roughly two-thirds of the world exports in 1939. In that year India was responsible for approximately 38 per cent. of the total world export, Ceylon for some 26 per cent., Nyasaland and Kenya each for something over 1 per cent., while the Union of South Africa, Tanganyika and Uganda each provided smaller quantities. On a *per capita* basis, Australia, New Zealand and Eire are, with the United Kingdom, by far the largest consumers of tea.

This book will be welcomed by all who know the author's earlier work on the subject of coffee (see this BULLETIN, 1943, **41**, 251-252), though in this case there may be some mild disappointment as the question of tea regulation seems to provide the author with less scope for his investigation. Nevertheless, he has prepared a valuable study which brings together in a critical survey much useful information.

As a result of Mr. Wickizer's survey and investigation, which forms the subject matter of the book, he concludes that " operation of the International Tea Exports Regulation Scheme since 1933 demonstrates the feasibility of control more convincingly with tea than with most other commodities that have been subject to regulation." As is shown in this account tea regulation has not so far presented insoluble problems, and the producing industry has obtained substantial advantages without apparent serious detriment to the consumer. Agreement between the British and Dutch interests controlling the output of the principal "black tea" producing areas has served to produce a workable scheme, though the eventual inclusion of all major tea growing countries would seem likely to be necessary for the achievement of post-war stability. Very considerable export surpluses might become available from the present " green tea " territories following the termination of hostilities in the Far East, as these countries could readily turn out the black tea of European commerce.

In the foreword the book is described as " a product of researches exploring the general idea that post-war commodity problems can be effectively dealt with by international bodies set up under

international commodity agreements." Some form of international authority to sponsor and guide such agreements would seem to be a necessary development if commodity control is to succeed.

E. H. G. S.

Propagation by Cuttings and Layers. Recent Work and its Application, with special reference to Pome and Stone Fruits. By R. J. Garner. Imperial Bureau of Horticulture and Plantation Crops, Technical Communication No. 14. Pp. 79, $9\frac{3}{4} \times 7\frac{1}{4}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1944.) Price 3*s*. 6*d*.

This is a very useful publication, being an account of propagation written by a practical expert. The work falls into three parts, a comprehensive review of the literature, a discussion of the application of research and of the methods employed at East Malling Research Station, and the writer's "thoughts on future research." In addition to the extensive bibliography, there are author and subject indexes; the latter will be particularly welcome to the many who will use the publication for reference purposes. Moreover, there is at the beginning of the work an excellently detailed contents list. None of this space is wasted, and obviously the Imperial Bureau and the author appreciate the supreme importance of making their publications both readable and usable by the technical worker. Too many publications of this nature and length are lacking in this respect.

In his review of the literature, Mr. Garner considers propagation by cuttings under three main headings: source of material, handling of cuttings prior to planting, and planting and subsequent treatment. Young plants are usually the better source of material, leaves on stem cuttings are a definite advantage, flowers an adverse factor, and the use of lateral shoots is normally preferable. Synthetic growth substances have given variable results, but used with discretion they assist rooting. An important conclusion is that "neither moisture nor temperature nor—probably—light effects should be considered separately." Nurse grafting whereby shy rooting stem and root cuttings may be induced to root is discussed. Of primary importance in the rooting medium is good aeration accompanied by moisture. Reference is made to the use of "callusing pits" in Florida, in which inverted hardwood cuttings are placed for a period to form calluses.

On the subject of propagation by layers, the main sections are stooling, layering, and marcotting. Stool beds, where this method is applicable, are a ready means of multiplying material. The East Malling etiolation method of layering is discussed. The success of marcotting depends on thorough ringing and a constant moisture supply. Growth substances have in some instances "improved the rooting of etiolated layers and marcots."

The section on the application of research and methods used at

East Malling Research Station is a valuable feature. Some excellent line drawings illustrate this part of the text.

The work is of particular importance in relation to increasing demand for clonal rootstocks. In horticulture the rootstock is half the tree, and as Dr. Hatton indicates in his foreword it is vital that adequate supplies of the best rootstocks should be available for post-war planting.

As regards the United Kingdom, the amateur, in particular, should pay as much attention to obtaining a suitable rootstock for his requirements and conditions as is devoted to the choice of the scion variety. Those responsible for supplying the needs of the private gardener should surely do all in their power to provide for such discrimination and, moreover, to encourage it. The good results likely to be obtained from the amateur planting trees of the right type for his particular circumstances should do much to expand the demand for nursery material.

E. H. G. S.

ALTERNATE HUSBANDRY. Imperial Agricultural Bureaux Joint Publication No. 6. Pp. 157, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1944.) Price 5s.

The term " alternate husbandry " is defined in this publication as " a planned and regular alternation on every field of a farm or other agricultural unit of a period of arable husbandry with a period of direct animal use, in which the composition of the herbage or forage mixture is so adjusted as to provide a maximum amount of fodder of the proper type and at the proper time for the animal crop that is to be produced, and at the same time so as to provide for the maintenance of an optimal state of fertility or productivity in the soil throughout the whole course of the rotation." The work is a review of the present state of development in agriculture attained by alternate husbandry, and is published jointly by the Imperial Bureaux of Pastures and Forage Crops, Soil Science, Animal Breeding and Genetics, and Animal Health. Several authors have provided the nine chapters making up the publication, which has been compiled with wide reference to published information, augmented by correspondence and memoranda contributed by a large number of authorities at home and overseas. The various sources of information are noted in the bibliography.

As a commencement R. O. Whyte gives an extensive review of the developments towards alternate husbandry in a number of selected countries, with an outline of the present position. There follows a discussion of the influence of herbage rotations on the soil by G. V. Jacks, with particular reference to work in the Soviet Union. Whyte then returns with valuable accounts of the roots of herbage plants, and the types of leys. By contrast, chapter 5, contributed by J. E. Nichols, concerning the animal crop in relation

to alternate husbandry seems rather disappointing. The chapters regarding fertility types and current problems, also by R. O. Whyte, are important features. It is recognised, for example, that the practice of alternative husbandry may not be desirable in the wet tropics. An interesting account of the management of pasture in relation to animal disease is written by E. L. Taylor. The work concludes with a study of economic factors affecting a change to alternate husbandry by Professor A. W. Ashby and W. J. Thomas.

In all, this is an opportune publication and one that will indicate to the agricultural scientist likely lines of work that are proceeding in other countries, of which he might not be fully aware. It is recognised that alternate husbandry has no universal application in farming, and that it has no inflexible rules. It is clear from this survey that much research and investigation will be necessary in many areas and directions before ley farming can be fully developed.

As the publication is essentially a summary of published information and private communications anything in the nature of a detailed review is impracticable. There does appear, however, to be a tendency in places to excessive wordiness, which is unfortunate if the publication is to have the widest appeal.

E. H. G. S.

PASTEURISATION. By Harry Hill, F.R.San.I., A.M.I.S.E., F.S.I.A. Pp. viii + 152, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: H. K. Lewis & Co., Ltd., 1943.) Price 10*s*.

Growing attention is being given by public authorities to the provision of "safe" milk. It is well established that milk can be the responsible agent for the transmission of infectious diseases. The occurrence of disease-producing organisms in milk could no doubt be prevented by using only perfectly healthy cows and by handling the supply in a thoroughly hygienic manner. But the difficulties that are met in practice are such that this high ideal cannot be attained. Some method is therefore essential whereby milk can be freed from harmful organisms and rendered safe for human consumption. The process of pasteurisation is generally adopted for this purpose. Several adverse criticisms have been made of this method of treating milk, such as that raw milk is not responsible for the conveyance of tuberculosis, and that the nutritive properties are destroyed thereby.

The author in the earlier chapters of this book deals with the causes that render the treatment of milk necessary to ensure a safe supply. He replies to the adverse criticisms and quotes evidence to prove that they are fallacious. Chapters follow on plant design and the processes of pasteurisation in general use. These sections have for their aim the provision of a thorough understanding of the treatment, which is important not only for the public health official but also for the plant operator.

Emphasis is laid upon the necessity for cleanliness in the handling

of the plant and the bottles used. Sections are accordingly devoted to methods for the efficient washing and sterilisation of bottles, their filling and capping, as well as to the cleansing of all the equipment employed in the pasteurisation process. The final chapter describes the control measures, such as inspection of plant and methods and laboratory control, that should be taken to ensure that the process is satisfactorily carried out and that the resulting product is all that is desired.

G. T. B.

THE CHEMISTRY AND PHARMACY OF VEGETABLE DRUGS. By Noel L. Allport, F.R.I.C. Pp. viii + 264, 9 × 6. (London : George Newnes, Ltd., 1943.) Price 17*s.* 6*d.*

The author states that this book is designed to answer the many questions which must arise in the mind of the student of pharmacy when making his preliminary acquaintance with the numerous vegetable drugs and their galenical preparations. To this end the more important drugs of each group are described individually, while drugs of secondary importance are frequently grouped together. In this manner an easily readable and attractive account of the subject is presented to the student, the matters of importance being given prominence and adequately treated for the purpose in hand, while the lesser *materia medica* are given the lesser notice which they merit. The matter is up to date, but no references to original literature are given, and in some cases these are very desirable. For instance, the worker employing the determination of rotenone in derris, as described in three-quarters of a page (182), would undoubtedly benefit by the amplification derived from studying at least a part of the literature of the method.

There are twenty-two chapters in the book, which generally represent the recognised groups of drugs, or in the cases for instance, of opium and cinchona, a chapter is justifiably devoted to the individual drug. The drugs are described, and accounts of their sources, chemistry, uses and assay are given. In a book of this small size the large subject covered is of necessity written up with due regard to space, in which the author has been most successful, for while references to larger treatises will no doubt be necessary in due course for the student, here is an excellent introduction that forms very pleasant reading.

J. R. F.

PLASTICS—SCIENTIFIC AND TECHNOLOGICAL. By H. Ronald Fleck, M.Sc., F.R.I.C. Pp. li + 325, $8\frac{3}{4} \times 5\frac{1}{2}$. (London : Temple Press, Ltd., 1944.) Price 25*s.*

There are fifteen chapters in this book, which deal with the history of plastics; raw materials; principles of polymerisation; chemistry and manufacture of plastic materials; synthetic elastomers; physical properties of thermo-plastic and thermo-setting

materials ; synthetic resins, fibres and textiles ; adhesives, plywood and impregnated wood ; manufacture of dies and moulds ; production of plastic articles ; the chemical, physical and electrical testing of plastics ; and the chemical analysis of raw materials. Associated data are given as appendices, and there is a good index.

The book is a very satisfactory survey of the present stage of our knowledge on the scientific and manufacturing sides of the plastics industries. It is well presented and provides a good work of reference, preliminary to consulting original papers on the subject.

The format of the book suffers through the employment of small type, no doubt in consequence of war-time economy, but this has not prevented the unwelcome inclusion of 46 pages of advertisements.

J. R. F.

A HANDBOOK FOR THE IDENTIFICATION OF INSECTS OF MEDICAL IMPORTANCE. By John Smart, Ph.D. Pp. x + 269, $9\frac{3}{4} \times 7\frac{1}{4}$. (London : British Museum [Natural History], 1943.) Price 15*s*.

The rapidly growing science of medical entomology, that is the study of insects in their relation to disease, has, it seems, been better served by literature dealing with the control of insect agents of disease than with the important matter of the recognition of the insects themselves.

In general, the procedure has been to send specimens for identification to such organisations as the British Museum (Natural History) or the Imperial Institute of Entomology. It is emphasised by the author in his preface that these two institutions exist for this purpose and for giving advice where it is needed. But these services are carried on under difficulties in war-time, and the present volume should do much to enable workers to dispense with such aid, thereby often saving considerable time. It deals with all the insects of the Old World known to be of importance in medicine and hygiene. The text is limited to what is essential for correct identification, an elementary knowledge of general entomology and some acquaintance with medical entomology being assumed, and is accompanied by numerous excellent illustrations.

F. F.

MINERAL RESOURCES

ARTICLE

THE INTERNATIONAL MERCURY SITUATION[1]

By E. R. Varley, Ph.D., B.Sc., D.I.C.,
Mineral Resources Department, Imperial Institute

Before the war, mercury alone of all the metal and mineral raw materials was the one commodity in which the United Democracies, considering their combined requirements and supplies, were seriously deficient. Moreover, it was the outstanding metal which the Axis powers possessed in super-abundance. This situation, however, gave rise to no feelings of aggressive envy or "have-not" frustration on the part of the Democratic Countries which purchased their requirements of mercury to a considerable extent from countries favourably disposed towards the Axis and were content to do so.

With the outbreak of hostilities, therefore, the Democracies were faced with a serious situation with regard to mercury supplies, but what they lacked in foresight they have made up in planning and energy. The result of this, as will be seen from the following analysis, is to place the Democratic Countries in a by no means unfavourable position with regard to supplies of mercury for war purposes.

Of these countries, the United States is by far the most favourably placed, and by virtue of increasing their domestic production and by their economic policy and planning, the Americans have been able not only to fulfil their domestic requirements but also to improve the supply position of those countries which they are so generously helping. On a smaller scale, but none the less valuable in helping to ease the general supply position, the countries of the British Empire have been developing existing and new sources of the metal and have backed these efforts up by effecting economies, by cutting out less essential uses and by the use of substitutes wherever possible. In addition to these measures, an important factor in the present situation is the diversion of supplies to the United Nations from countries favourably disposed, such as Latin America, which formerly supplied Japan to a large extent. Recent events in Italy, whilst perhaps not immediately adding to the Allied supplies, have unquestionably altered the Axis position.

[1] Reprinted, with revisions by the author, from *Metal Industry*, March 24, 1944, by permission of the Editor.

CONSUMPTION OF MERCURY

Mercury is a very important raw material to all industrial countries because of the wide range of applications to which it is put and because for some of its most important uses, few, and in some cases no satisfactory substitutes are known. Although mercury is commonly visualised as the liquid silver-coloured metal, in point of fact only about 25—30 per cent. of total consumption is normally accounted for in the metallic form. Mercury salts in the form of drugs and chemicals account for about 40 per cent. of normal consumption, mercury fulminate which is used as a detonator in many types of munitions and industrial explosives takes about 19 per cent. and 15 per cent. goes as quicksilver into scientific instruments and electrical apparatus. The remainder is consumed in the treatment of felt, in the manufacture of anti-fouling paints, vermilion pigments, caustic soda, glacial acetic acid and mercurial solders, and in the amalgamation process of gold and silver recovery, although from the economic point of view this last is probably the most important use.

Even if mercury were plentiful, it is obvious that there would be some change in the proportions used in various industries of countries at war, but none of the belligerent nations have given any indications of the amounts or proportions which they are using for their more essential purposes. It is said, however, that the increase in the proportion of mercury that goes into the manufacture of fulminate for detonators is not so great during war-time as might be anticipated. During the last war the increase for this usage in the United States, for example, was only from 17 per cent. to 19 per cent. This is held to be due partly to the diversion from ordinary industrial explosives and partly to the economy effected by using a smaller quantity of actual detonator and inserting a "booster" between it and the charge proper.

As has already been indicated, there are few, and for some uses no satisfactory substitutes for mercury, particularly where it is used in the metallic form. In the field of explosives, however, lead azide can be used in place of fulminate, but some authorities do not regard this as reliable as fulminate for military explosives. For anti-fouling paints, vermilion pigments, and disinfectants, alternative substances can be found, thereby enabling the mercury available in a country where it is a deficiency commodity to be restricted to the more urgent applications.

PRE-WAR SOURCES OF SUPPLY

The British Empire production of mercury before the present war was so small as to be almost negligible in any survey of the international market in this commodity. Out of a total world output of over ten million pounds of mercury in 1938, for example, only about 1,500—2,000 lb. came from Empire sources (see Table I), and even this small amount was declining up to the outbreak of hostilities.

TABLE I.—MERCURY—WORLD PRODUCTION

Country.	Quantity (lb.) 1936	1937	1938	1939	1940
Canada	—	—	760	436	153,830
Australia	5,911	710	—	249	(d)
New Zealand	—	1,344	760	—	—
Southern Rhodesia	—	—	—	32	(d)
Union of South Africa	—	—	—	—	3,329
United States of America	1,259,244	1,254,608	1,367,316	1,416,108	2,871,052
Mexico	403,355	375,132	647,460	560,567	885,630
China (Exports)	186,928	131,925	4,941	988	475,735
Bolivia (Exports)	16,885	1,217	(a)	569	—
Turkey	63,504	37,269	45,408	27,284	—
U.S.S.R.	588,735	600,000 (c)	600,000 (c)	600,000 (c)	—
Italy	3,247,620	4,868,000	5,073,000	5,103,704	—
Spain	2,158,000	2,923,000	3,146,000	2,729,000	4,141,700 (b)
Austria	220	10,192	(a)	(a)	(a)
Czechoslovakia	142,546	208,989	220,000	(a)	(a)
Japan	32,571	44,000 (c)	45,000 (c)	(a)	(a)
Tunis	5,470	1,911	20,536	(a)	(a)
Algeria	8,823	9,429	15,252	(a)	(a)

(a) *Not available.* (c) *Estimated.*
(b) *Exports.* (d) *Not available for publication.*

The United Kingdom is entirely dependent upon imports which in recent years have been of the order of two or three million pounds weight as will be seen from Table II.

TABLE II.—MERCURY—IMPORTS INTO THE UNITED KINGDOM

Country of Origin.	Quantity (lb.) 1935	1936	1937	1938	1939
British Empire	—	7,500	—	375	1,200
Spain	1,419,328	1,404,466	2,598,981	2,939,946	1,744,450
Italy	65,379	1,520	997,275	126,037	234,342
Mexico	412,960	271,948	158,628	295,088	275,495
Other foreign countries	19,866	22,096	37,086	6,625	7,886
Total	1,917,533	1,707,530	3,791,970	3,368,071	2,263,373

Country of Origin.	Value (£) 1935	1936	1937	1938	1939
British Empire	—	1,264	—	71	257
Spain	209,164	222,009	418,658	437,586	318,724
Italy	9,792	280	169,637	20,987	45,100
Mexico	60,376	43,604	28,508	48,405	56,935
Other foreign countries	2,779	3,486	6,200	1,224	1,880
Total	282,111	270,643	623,003	508,273	422,896

It will also be seen from this table that Spain and Italy together provided the greater part of our imports, as, in fact, they did of many other parts of the Empire and many foreign countries. Indeed the combined Italian and Spanish production accounted for about 80 per cent. of the world's total output and was therefore one of the predominating influences in the world mercury market.

The output from these two countries, which came from three

Italian mines, those of Monte Amiata, Idria and Siele, and the high-grade Spanish mine of Almaden, was controlled by a cartel known as the Mercurio Europeo. The actual disposal of the metal, however, was not made by the cartel themselves, but through the medium of a sales agency, which for a number of years prior to hostilities had been awarded to a London firm. Before the entry of Italy into the war, negotiations were in hand for the transfer of this sales agency to neutral territory and it is, in fact, now vested in a company with headquarters in Switzerland.

United Kingdom Position

The supply position of the United Kingdom during the present war has been vastly different from that during the last war, when, in addition to the supplies which were available from Italy, the entire output from the Almaden mine in Spain, with the exception of about a thousand flasks annually for Spanish domestic requirements, was controlled by the British Government through Messrs. Rothschild.

The complete cessation of supplies from Italy and a certain amount of restriction in those from Spain necessitated a strict measure of official control in the United Kingdom. This control consists in the banning of private imports, and the fixing of an official price (now £68 10*s*. to £69 15*s*. per flask of 76 lb. according to quantity). The rather odd size of 76 lb. for a flask of mercury arises from the fact that the metal, produced as it was from quite early times in Spain, was sold in centals or Spanish hundredweights of a hundred libras, the libra being equivalent to 0·76 lb. A flask of 76½ lb. was in use in the United States prior to 1904, when it was reduced to 75 lb., but since 1927 the Americans have come into line with European practice.

During the last war period the price varied from a minimum of £6 10*s*. per flask in July 1914 to £23 10*s*. at the end of 1919 and to £25 per flask in 1920. During 1938 the average price was about £13 14*s*. per flask. At about five times the pre-war price, mercury at the present time may, at first sight, appear to be inordinately dear, particularly in view of the general policy of this country to prevent excessive rises in commodity prices. In the case of mercury, however, it will be appreciated from the above considerations, that the high price is in effect beneficial in the ultimate analysis in that it has had the effect not only of stimulating both new and additional production by making low-grade deposits payable, but also of curbing the consumption of the metal and its salts in the less essential uses to which it is normally put.

Empire Production

Among the countries of the British Empire, Canada is the most fortunately placed with regard to supplies from domestic resources. British Columbia is the principal province in which cinnabar occurs,

and the production from the Pinchi Lake and other mines has been expanded to such an extent that even by the middle of 1941 Canada was not only entirely supplying its own requirements but was said to be in a position to produce a very considerable part of the requirements of the British Empire. Canada's production increased from 153,830 lb. in 1940 to 536,304 lb. in 1941, 1,035,914 lb. in 1942 and 1,709,000 lb. in 1943.

This addition to the allied supplies of quicksilver is all the more welcome and remarkable when it is remembered that Canada was formerly a considerable importer of the metal, having required about 200,000 lb. in the first two years of the last war, but managing on about 60-80,000 lb. in 1917 and 1918. (See also Table III.)

TABLE III.—MERCURY—IMPORTING COUNTRIES
(Less Re-exports, lb.)

Country.	1936	1937	1938	1939	Remarks.
United Kingdom	1,284,155	1,654,348	2,190,235	454,911	
Southern Rhodesia	40,857	39,622	36,683	27,532	
Tanganyika	2,372	1,681	2,324	5,295	
Union of South Africa	86,730	69,684	46,610	80,487	
Canada	78,781	394,354	49,584	109,232	
	£949	*£1,960*	*£1,031*	*£2,054*	Mercury salts
British Guiana	1,893	3,836	1,549	2,323	
British India	53,076	235,706	155,309	194,649	
British Malaya	3,239	2,634	2,819	3,164	Total Imports
Burma	(b)	9,633 (b)	7,793	11,243	
Hong Kong	160,400	141,200	131,700	177,733	Total Imports
	£1,777	*£1,820*	*£706*	*£252*	Vermilion
Australia	73,894	80,658	61,160	(a)	
	17,527	17,262	24,766	(a)	Mercury salts
New Zealand	5,318	3,278	3,520	1,527	
U.S.S.R.	44,100	(a)	(a)	(a)	
Egypt	2,906	4,766	4,376	(a)	
United States	1,374,652	1,437,712	179,522	265,944	
	1,334	78,284	13,062	40,411	Mercury salts
Germany	1,517,400	1,968,100	2,498,900	921,800(c)	Quicksilver and amalgam
	21,200	1,500	400	200(c)	Mercury salts
Japan	1,128,723	(a)	(a)	(a)	

(a) *Information not available.*
(b) *Included with India to April* 1, 1937.
(c) *January-June only.*

South Africa has also taken active steps to improve her mercury position. With her consumption in explosives and in amalgamation as well as in a number of miscellaneous ways, the Union was normally a considerable importer of quicksilver (see Table III), largely from Italy and Spain, and did not produce an ounce of the metal. Deposits of mercury ores have been known for some time in South Africa, notably at Monarch Kop in the Murchison Range, at Hectorspruit in the Barberton district, and at Bynestpoort and Kameelfontein immediately west of the Premier diamond mine in the Pretoria district. Output in South Africa commenced in the

middle of 1940, and by the end of 1941 the Union was producing one-third of her requirements, and, in 1943, output is reported to have reached about 90,000 lb., sufficient to satisfy all her requirements for gold recovery and for the manufacture of munitions.

Australia has also been one of the Empire's heavy importers of mercury in the past (see Table III), and though at one time the Commonwealth produced as much as 5,900 lb. of the metal in a single year, her production has never constituted more than a relatively small percentage of her requirements of mercury and mercury salts, which in 1937 were of the order of nearly 100,000 lb., 50 per cent. of which are normally for use in Australia's gold mining industry. The principal deposits are located at Kilkivan in Queensland, and almost immediately after the outbreak of war, production at an idle mine in that district was recommenced. Other occurrences are known (for example, in New South Wales), and although Australia will probably still require considerable imports, she will undoubtedly be able to make a substantial domestic contribution to her requirements.

New Zealand, which has been an intermittent producer of mercury, stepped up her output towards the end of the last war to over 11,000 lb. annually. The principal deposit, that at Puhipuhi in the Auckland province in North Island, has, as a result of war conditions, again been opened up, resulting in a small but useful contribution to our total output.

United States Activity

At one time, the United States was the foremost producer of mercury in the world, but output declined with prices, and in 1914 was actually the lowest on record for 50 years. In fact, the United States affords an excellent example of the reaction of price on output. During the last war a considerable rise in the price of mercury took place in the United States, reaching its zenith in February 1916, when a fantastic peak of $300 per flask was reached. The resulting impetus during the last war led to the production being nearly doubled, the peak being 2,711,925 lb. in 1917, but after the war output again declined. A similar trend has already been witnessed during the present war, when before the full benefit of increased domestic production, control and acquisition from abroad was felt, the price was pegged for the whole of the United States, with the exception of Arkansas and Texas, at $195 to $197 per flask, f.o.b. at the place of origin. Things have so far improved, however, that the price has now eased to only $116 (£29) per flask. In this connection it is of interest to note that the peak price asked by the mercury cartel during this war was $250 per flask in December 1940.

The renewal of high prices has again brought about greatly increased production, not only from existing and hitherto dormant mines, but also from small or low-grade deposits which are normally

unremunerative. United States production comes almost entirely from the Western States, and is largely contributed by California, Oregon, Texas, Nevada, Arkansas and Washington.

Further to the increases shown in Table I, production was expanded to 3,413,996 lb. in 1941, 3,864,296 lb. in 1942, and by 1943 it had amounted to 4,069,496 lb. or about three times the 1938 output. This is not a record for the United States, however, since in 1877, with a production of 6,074,000 lb., the United States was responsible for two-thirds of the entire world production of this metal. Nevertheless, considering the long period of mercury production in the United States and the fact that a high proportion of the best ore has long been taken out, it is a very remarkable achievement to have been able to expand output again to some 55,000 flasks in a single year.

This increased output enabled the United States, which for a number of years had been producing only about 65 per cent. of her requirements (Table III), not only to become self-sufficing but also to have an exportable surplus. This was of inestimable value to the British Empire, the United Kingdom alone receiving over 5,000 flasks or some 175 tons of mercury during 1940. The defence programme of the United States and her eventual entry into the war absorbed the margin for export from domestic production, but the position was more than restored by acquisition from the very considerable producers of Latin America. The entire exportable surplus of Mexico, for example, which was expected to be of the order of 400 to 500 tons of mercury annually, was made available for "hemisphere defence." Actual production in Mexico turned out to be considerably in excess of that estimate as shown below.

In spite of her comparatively comfortable position with regard to supplies of quicksilver, both for domestic consumption and for lease-lend aid to the Democracies, the United States has taken strict measures to conserve her output and stocks of the metal, and by an order which came into force in January 1942, such civilian commodities as certain fungicides, wood-treating chemicals, domestic thermometers and anti-fouling paint, ceased to be manufactured. Mercury fulminate, fluorescent lamps and industrial and scientific apparatus, however, continued to be manufactured at a rate parallel with that ruling in the first quarter of 1940.

Other United Nations Supplies

Mexico has for many years been an important producer of quicksilver, being surpassed only by Italy, Spain and the U.S.A., and most of her output has been available for export (Table I). This export, in recent critical years, was largely cornered by Japan, but with the spread of the war this trade was increasingly curtailed by Mexico until eventually a decree was issued making her exportable surplus available only to the U.S.A. and the Western Hemisphere. Mexico's production rose to 1,758,457 lb. in 1941,

and in the first two months of 1942 reached the remarkable rate of 3 million lb. a year, a very important contribution to the allied resources of the metal.

Russia's production of mercury has not been officially declared for some years, but it is believed to be normally of the order of 600,000 lb. annually, and as her imports for the last available year were only 44,000 lb. Russia is normally self-sufficient for her more essential uses. In 1938, the entire production came from the group of the Nikitovski mines in the Donetz basin, which have been worked for fifty years. Supplies from this source have therefore been interrupted, but deposits of mercury are known in other parts of Russia, notably in the Kirghiz, and in addition, in the latest year for which statistics are available, it is known that China was supplying Russia with mercury.

China itself has been an important producer of mercury for many years, her exports alone having been usually between 100,000 and 200,000 lb. annually. There was naturally almost a complete cessation of exports after the Japanese aggression, but mercury provides an example of China's magnificent resuscitation of her industries in spite of appalling difficulties, in that her production for 1940 was actually greater than in peace-time.

With regard to the rest of the Empire, the United Nations and the favourably disposed countries, neither India nor the Colonies are important producers of mercury, but most of the South American countries possess mercury deposits which are either actually in or are being put into production for their own use or for hemisphere defence.

The Axis Position

Germany and Italy together had no mercury problem since Italy's domestic consumption in normal times was of the order of only 5 per cent. of her production, and she had an annual exportable surplus of some 2,000 metric tons or nearly 60,000 flasks.

The Italian quicksilver deposits are located in Idria and Tuscany. Those in Tuscany, the Monte Amiata, Siele and Argus mines, are already in Allied hands, though no information is yet to hand as to the state in which they were found. An unconfirmed report also states that the Idria mines in the Trieste district, which are responsible for the balance of Italian mercury production, were completely destroyed by Yugoslav partisans early this year. Hence, although there was an appreciable production of mercury in Czechoslovakia, and a certain amount was also forthcoming from Austria and Roumania, it would appear that Germany had ultimately to rely more and more upon imports from Spain for supplies, since production in Germany itself is almost insignificant.

Like Italy, Spain also had a considerable surplus for export, which was available to the European end of the Axis. Germany is reported to have taken 22,770 flasks, or more than a half of the

total Spanish exports in 1941, but this fell to 6,000 flasks in 1942, and 3,840 flasks in the first half of 1943, suggesting that until the latter date Germany was obtaining its requirements largely from Spain.

Japan has for a number of years produced between 30,000 and 50,000 lb. of mercury annually, and within recent years this, it is believed, has been more than doubled. Even so, this is far short of her requirements, and in the last year for which statistics are available, 1936, she imported well over a million pounds of the metal, whilst in 1939 she imported 750 tons in 10 months. It is manifest, therefore, that she was stockpiling against the eventual cutting off of supplies, a substantial part of which she was obtaining from Latin America.

Conclusion

It will be seen, therefore, that although the Democracies were initially less favourably placed with regard to mercury supplies than the Axis, particularly the European end of it, adequate supplies of the metal at least for essential war purposes, have been assured to the United Nations by their expansion of output, curtailment of non-essential uses, and the acquirement of some of the supplies that formerly went to the Axis.

Moreover, a very considerable upheaval in the world mercury market has taken place owing to the influx of many new sources of supply. Some of these admittedly are economic only at the present high price of the metal, and a return to more normal times will undoubtedly see the elimination of many of these producers. Nevertheless, it is believed that some of the present deposits will be able to continue as considerable contributors to world supplies, a condition which would result in a permanent curtailment of the hitherto almost monopolistic control of the market.

ABSTRACTS AND NOTES

Mineral Resources of Tanganyika Territory.—A second edition has recently appeared of Bulletin No. 16 of the Geological Division of the Department of Lands and Mines, Tanganyika Territory, entitled "The Mineral Resources of Tanganyika Territory," by Sir E. O. Teale and F. Oates (Dar es Salaam, 1943). It is a comprehensive printed publication of some 200 pages, replacing the first limited typescript edition and constitutes a comprehensive stocktaking of all the mineral resources of a young country.

This valuable work of reference is divided into three parts: the first on the 12 minerals at present being worked, the second on the 128 minerals occurring in Tanganyika but not at present being worked, and the third a section called "Mineral Information." The last-mentioned consists in the main of general trade information

relating to a number of minerals of commercial importance said to have been compiled from all available sources but in which, not unnaturally, the influence of Imperial Institute publications and diagrams therefrom is sometimes most marked.

In the general considerations preceding the section on gold certain generalisations are propounded which have a most profound bearing on all prospecting for metalliferous minerals, not only in Tanganyika Territory but in much of East and East-Central Africa.

More ambitious schemes for the classification of the granites have been abandoned by the authors, who have returned to the original, broad South African classification of old granite and young granite. The important characteristic of the young granites is that they all attained a fully magmatic phase prior to injection into the Upper Basement Complex or Muva Ankole rocks, in contrast with the older granites, which seem to have been generated quiescently and metasomatically through permeation of pre-existing, deeply buried formations by uprising alkalic liquids. In the magmas of the younger granites some opportunity arose for magmatic differentiation, leading eventually to concentration of the metallic components in residue-liquors and their final injection as metalliferous lodes. Thus gold, tin and other metals are associated with the young granites but not the old. It is believed that this generalisation applies to the whole of the Tanganyika-Kenya-Uganda gold province. Thus economic gold lodes invariably appear to be associated with the young type of granite and with rafts of meta-sedimentary and meta-volcanic rocks occurring in it. It is the younger granites that indicate loci of mineralisation, particularly in regard to gold, silver, tin, copper, lead and diamonds. Experience has tended to show that prospection of the older granites and Lower Basement Complex for these minerals is fruitless.

In Tanganyika, the principal gold formation is the Upper Basement Complex, the Muva-Ankolean rocks displaying tin-tungsten mineralisation only. In Kenya, gold mineralisation is associated with rocks that are the equivalent of the Tanganyikan Upper Basement Complex, and there are no tin-tungsten deposits. In Uganda, both tin and gold are associated with the Muva-Ankolean in what appears to be zonal relationship, the zones running parallel with the general axis of the younger granite intrusions. From the aspect of economic geology, the authors observe that it is unfortunate that the division of this mineral province between three British dependencies and Belgian Ruanda has prevented its co-ordinated survey, which fact alone is surely one of the strongest reasons for a fully co-ordinated East African geological service.

Gold

The Goldfields of the Lake Victoria Region. The goldfields of this region are conveniently divisible into those of Musoma, East Mwanza and South-west Mwanza. In contrast to the Lupa, where the gold production for many years was almost entirely of placer

origin, the Lake Victoria region has yielded little or no gold of this type. Production from reefs, however, dates from before the war of 1914-1918, and since 1923 the yield from this source has been continuous and steadily expanding. The increase was most marked in 1939, owing to the coming into operation of the new Geita mill, treating 250 tons per day; the new plant at Buhemba, which started up only towards the end of 1939 with a capacity of about 120 tons per day; and the Mara Mine, with a capacity of about 100 tons per day. Since then Geita has doubled its throughput. Thus the total bullion produced in the Lake Province has increased from 7,431 fine oz. in 1935 to 84,258 fine oz. in 1941.

The gold deposits of the Lake Victoria region may be described under the following natural categories:

1. Quartz reefs.—Typical producing mines are Mara, Buhemba, Ikungu, Phoenix (formerly Mrangi) and Mawe Meru.
2. Impregnations of the country rock, which is commonly banded ironstone but includes also epidiorite, rhyolite, etc.—Typical of this kind of occurrence are Geita, Lone Cone, Ridge 8, and others in the district west-south-west of Mwanza. Kiabakari, Kitario, Nyasirori (in part) are examples of this type of deposit in the Musoma District.

Both types as a rule are found in zones of shear or fracture in members of the Upper Basement Complex in the vicinity of granitic or associated intrusions. In detail, the geological setting varies much from place to place. In addition to ordinary quartz reefs, which are more easily recognised, there is the widespread occurrence of auriferous pyritic impregnation. Such deposits are more difficult to locate, to prove and to work; they are therefore more amenable to company organisation since they are usually of low grade, but offer large tonnage.

In 1941 the Musoma goldfield crushed 95,457 long tons of ore and produced 31,015 oz. of gold, giving an average recovery of 6·4 dwt. per ton. About 88 per cent. of this production came from the Buhemba, Mara, and Ikungu mines. Owing to war conditions, the Mara mine has since ceased production.

The East Mwanza Goldfield. Geologically, this is a southern continuation of the Musoma field. There was only one producer in 1939, and although this field has no longer any production, it lies, nevertheless, within a belt of country favourable for the occurrence of gold-bearing reefs.

The South-west Mwanza Goldfield. This area has come into prominence owing to the successful activities of the Geita Gold Mining Co., Ltd., and the associated interests (Mawe Meru, Lone Cone, Ridge 8, and Prospect 30). The Geita mine is now the largest single source of gold in the Territory. After extensive exploration and development since 1934, this company completed the erection of a mill, with a capacity of 250 tons per day, which came into operation in January 1939. Plans for increasing pro-

duction were interfered with to some extent by the war, but throughput was doubled by early 1941, which enabled large sections of lower grade material to be profitably handled. Owing to war conditions, however, the Geita mine was later forced to reduce its throughput to 250 tons a day. The formations containing proved mineralisation are similar geologically to those of the Musoma goldfield and are similarly disposed to adjacent granitic intrusions. There is, however, a greater preponderance in this region of extensive pyritic impregnations over normal quartz reefs.

In the natural outcrop of the impregnation type of occurrence there is little to attract attention, for ordinary reef quartz is almost completely absent. The auriferous banded ironstone on close inspection shows a little more gossany character than the normal rock and often minute veinlets of quartz. Free gold is obtained from panning examinations; on trenching, a white, leached and decayed, light-coloured dyke is almost invariably found associated with the auriferous banded ironstones. In depth the mineralisation of the impregnation type of deposit is dominantly pyrite, with in places some pyrrhotite or arsenopyrite, or both, and there is a considerable amount of silicification but little true vein quartz. In the normal quartz reefs, such as Mawe Meru, the gold values are high, and in addition to abundant pyrite, chalcopyrite is also conspicuous.

In 1941 production from Geita, and the 1941 total for the whole of the South-west Mwanza field (including Geita) were as follows:

	Crushed. (*long tons.*)	Fine gold. (*oz.*)	Recovery (*dwt./ton*).
Geita . . .	161,480	49,716	6·1
Whole field . .	170,294	52,045	—

Goldfields outside the Lake Victoria Region.—The Lupa Goldfield is situated in the Southern Highlands, 450 miles by road from the railway at Dodoma, or 250 miles from it by a more recent and direct road at Itigi. It started as an alluvial field in 1922 and has since maintained an output from that source, only reaching its zenith of alluvial production in 1936. Since that date there has been a steady decline in the amount of placer gold won, but a corresponding increase in that obtained from quartz reefs, which are abundantly developed over an area of nearly 1,000 sq. miles. In 1939, there were over forty producing mines in this field. In 1941, the production of fine gold from alluvial sources was 14,389 oz. and from lode sources 34,368 oz. or a total of 48,757 oz. Most of the reef occurrences consist of a system of quartz lenses *en échelon* along a definite fissure or shear-zone often traceable for as much as two miles.

Other auriferous areas are the Iramba Plateau and Sekenke goldfield, and the Uruwira or Ukonongo goldfield. Underground work at Sekenke, the oldest and deepest mine in the Territory, ceased early in 1942.

Diamonds

Diamonds were discovered near Mabuki, south of Lake Victoria, prior to the war of 1914-1918, but it was not until 1925 that exports commenced. Since that date diamonds to the value of a little under half-a-million pounds sterling have been exported, chiefly from two occurrences, Mabuki and Kisumbi (near Shinyanga).

The diamonds come almost entirely from detrital deposits containing the characteristic suite of minerals associated with kimberlite occurrences. Between thirty and forty kimberlite occurrences have been found, chiefly as pipes but also as dykes and sills. Some of the pipes contain diamonds, but none has yet proved payable to work.

The diamonds won have included a good proportion of large size and high quality. The 1941 production was 29,052 carats, valued at £70,236, of an average weight of 0·635 carats per stone. Whereas, owing to war conditions, gold production has declined, the diamond production is being well maintained, many industrial stones being obtained from the Mwadui lease, the principal producer.

Tin Ore

Production during the war has been affected by shortage of labour, and declined slightly in 1941 to 335 tons, valued at £64,787.

Salt

The 1941 production of salt was 8,187 tons, which realised £45,847.

Mica

A wide distribution of muscovitic mica of good commercial value is known, and it has been marketed from many localities. War conditions and the consequent closure of the biggest producer, the German-controlled Uluguru Mica Mines, Ltd., have resulted in a serious drop in output. The 1941 production of 4·75 tons of sheet mica of estimated value of £2,650 is the lowest for any year since the slump of the early 'thirties.

Other Minerals

Numerous other minerals that are or have been worked, as well as many more that may possibly be worked some day, are dealt with in fair detail. Among those to which special attention is now being paid are coal, kaolin, abrasives, cement materials and graphite.

A. W. G.

Kenya Mining in Wartime.—The following notes have been released for publication by the Colonial Office.

As the war progresses, the production of gold in Kenya, which, before the war, amounted to roughly one-seventh of the value of the country's total exports, shows a steady tendency to decline. The decrease has been inevitable owing to the diversion of man-power, machinery and supplies into channels more directly connected with the war effort. Concurrently with this, the Mines Department

of Kenya has pursued a policy of developing the mineral resources of the Colony other than precious metals, mainly non-metallic minerals such as kyanite, bentonite, vermiculite, gypsum, and so on. These, though less spectacular in their appeal than gold or silver, are urgently required in the development of local secondary industries ; some even have possibilities of export. Moreover, their development has offset considerably the loss to the Colony in the contraction of the gold industry. At the same time, mining in Kenya is being put on a broader basis. The principle of associating private enterprise as far as possible with the development of any new mineral has been maintained.

In the goldfields, a large number of small workers have closed down and gone to the war, whereas practically all the larger firms are still working. Output of gold has not therefore been affected as seriously as might be expected in all the circumstances. Use is being made of much of the machinery previously working on gold and now converted in one case, for instance, to grinding Kisii soapstone into a substitute for talc. Kisii soapstone, familiar to many in the form of black or white vases, ash trays or modelled animals or humans, is now being produced by Kenya Consolidated Goldfields Ltd. at Kitere, South Kavirondo, both as a substitute for talc and as a filler in the manufacture of soap. Diatomite is produced at Gilgil in considerable quantities for the same purpose. Bentonite, won from Mr. Wilmot Eardley's farm at Athi River, is being used as a bond for moulding sand in foundry work. Gypsum is being produced near the Thika-Garissa road, not far from the Tana River, and is being used extensively for the local manufacture of plaster of Paris as well as blackboard chalk used by the Education Department during wartime. It is also used as a constituent in the manufacture of Portland cement. The development of an export trade in gypsum would probably be impracticable owing to the long and expensive haul by road and rail. Possibly, if some shallow-draught steamer transport was available down the Tana River this would solve the transport question.

The East African Industrial Board are using locally produced kyanite for the manufacture of fire bricks, locally produced kaolin in the manufacture of pottery, and are being supplied by the Macalder Mines, South Kavirondo, with pyrites for the local manufacture of sulphuric acid. Lime is being produced in considerable quantities both for agricultural and building purposes. Manganese dioxide, sufficient to satisfy local requirements for paint manufacture, has been produced by the Mines Department, which also did considerable work to determine the most suitable treatment for a graphite deposit at Tsavo, which is now being developed. Gold mining machinery at Kakamega has also been converted for the manufacture of cement asbestos boards, which are being produced on a considerable scale by one concern. The asbestos mine is in West Suk.

In the early stages, the marketing of these minerals is limited to local uses, their development in many cases being a necessary preliminary to the setting up of local industries. Many of these minerals are low priced and the cost of transporting them is out of all proportion to their market value. The value of these non-metallic minerals to the Colony is estimated to be of the order of £60,000 to £70,000 a year, based on the probable 1944 productions. Some, like graphite, kyanite and vermiculite, are as yet only at the investigation stage, but may offer scope for development which would be reflected in considerable stepping up of this source of wealth to Kenya.

Prospecting has been carried out by the Mines Department to prove or disprove in certain areas the existence of workable molybdenite, bentonite, manganese and phosphates. A five-year plan for a Geological Survey is now being drawn up by the Department to provide a sound basis for development of the mineral and water resources of the Colony.

Boring for Water in Uganda.—We are sometimes apt to forget the fact that water is a mineral and to overlook the important place it occupies in the activities of Colonial Geological Surveys. In the African Colonies especially the provision of water supply is one of the principal functions of a geological survey. In recent years much has been done in the application of geophysical methods to assist in the location of water supplies, and it is therefore of special interest that Water Supply Paper No. 1 of the Geological Survey of Uganda (*Water Boring in Uganda*, 1920-1940, by C. B. Bisset) should cover the whole period since the initiation of that Department's operations. In doing so it brings out very clearly the increasing proportion of successful boreholes since the responsibility for this work has come fully under the control of the Geological Survey, and the problems have been attacked in an increasingly scientific manner.

From 1920 to 1930 water-boring was one of the functions of the Geological Survey, though the same drills were also used in mineral exploration. During this period 10 holes out of a total of 16 bored for water gave a useful or potentially useful yield, and the results were sufficiently encouraging to justify the formulation of a wider scheme. It was, however, decided that the extended drilling organisation should be placed under the control of the Public Works Department, but that co-operation was to be maintained with the Geological Survey in respect of site selection and interpretation of results, while drilling for mineral exploration could be done as required.

This system of co-operation was in force from 1931 to 1937. In addition to both departments suffering from shortage of staff, the difficulties of divided responsibility arose. In 1936 these difficulties came to a head following on ten consecutive failures

and, as a result, in 1937 full control of the Drilling Section was once again vested in the Geological Survey. For the three years 1938-1940 there were 96 successes against 9 failures. In 1940, the best year of all, there were 38 successes against only one failure. Such results would appear to be the strongest vindication of the Government's reversal of policy.

The conventional hypothesis of a continuous body of underground water, the top of which roughly follows the contours, is found to be misleading in Uganda, where the underground water occurs in pockets or basins of variable type, extent and depth, rather than as a continuous water-table.

Considerable use has recently been made of geophysical methods of site selection. The conclusion reached is that while this means does not show a higher rate of successes in general work than ordinary methods it proves exceedingly valuable in relation to individual problems. Where there is a laterite cap it is possible to foretell the depth to unweathered rock, and whether there is water in the weathered zone, but not the amount or depth of such water. Its chief usefulness is in relation to small areas such as townships where some boring has already been done and more is required. Application of geophysical methods to such problems has undoubtedly saved considerable sums of money and much ineffective effort.

Little use has been made of rotary machines in Uganda. On the whole, percussion machines with internal combustion power units have proved the most satisfactory, particularly such types as are mounted or can be loaded on lorries for transport between sites. The hand pump is the most usual means employed for water raising, and Uganda is fortunate in that most of the supplies are within reach of these appliances. Windmills have been tried, but on account of uncertain wind strengths and difficulty of supervision they have not generally proved successful. Power pumping from boreholes has come into operation for several townships and Government stations. It is practicable only where there is a resident mechanic under responsible supervision, but probably more use could be made of this method.

Details are given of the drilling organisation. There are three heavy drills and some lighter machinery, and it has been found preferable to keep all the machines together and to use the Government Drilling Section as a single unit for work in areas where comparatively large numbers of boreholes are required. In this way problems of supply, control or movement of heavy drills have been vastly simplified. Thus a workshop, store and office within the drilling area have minimised the difficulty of maintenance both of drills and transport units, and it is not necessary to duplicate many heavy tools and fittings which are only in occasional use at each drill.

The second half of the report presents the detailed results of boring in Uganda and contains much information of more than local interest.

A. W. G.

Geological Work in Swaziland.—The Annual Report for 1943 of the Government Geologist for Swaziland, Mr. H. J. R. Way, records progress in the second year of the preliminary geological survey of the territory. It includes a provisional geological map of the country on a scale of 1 : 500,000, which, however, is still only an outline sketch map. The Swaziland System appears to be restricted to a belt about 6 miles wide and 50 miles in length in the mountain land of N.W. Swaziland along the Transvaal border, apart from small masses of phyllite exposed by the tin workings. From a study of aerial photographs it has been possible to observe that the Pongola series extends from the vicinity of Mahamba northwards as far as Ntungulukop near the Ngwempisi river, the ridges and structures of these resistant quartzites appearing remarkably clear from the air. This particular area has never been investigated geologically, and being very isolated will require quite an expedition to explore it. Most of the western part of Swaziland, however, is occupied by granite, mainly Older Granite, across which the tin-bearing zone stretches from N.W. to S.E. from Oshoek to Mhlatuzane river. The zone is about 10 miles wide near Oshoek, but thins to the S.W. to about 2 miles near the Mhlatuzane. The map shows eastern Swaziland as composed of Karroo rocks, with the sedimentary series (Dwyka and Ecca) resting on the granite and succeeded to the east by a great thickness of the Bushveld Amygdaloid and Lebombo Rhyolites.

Mineral resources investigated during the year include tin, tungsten, corundum, brick clays, calcite veins, coal, fluorite and iron ore. The general grade of the Swaziland cassiterite deposits is low, although some rich patches containing 6 lb. per cubic yard have been worked and are still to be found. An overall average figure, including overburden and gravel, given by McCreedy Tin Mines, is ½ lb. per cubic yard. Hitherto tin mining has been exclusively alluvial and eluvial working, but during the year a pegmatite body, more or less undecomposed, was exposed on Nyonyane Hill on McCreedy's Concession which contained workable quantities of cassiterite. Some 450 tons had been proved at the end of the year, and as soon as 1,000 tons had been proved it was intended to start mining and instal crushing machinery. New tin mining developments have taken place on Crown Mineral Area No. 14 at Makwanakop, where prospects appear to be fairly good, and Mr. Way recommends other portions of this Area to the attention of tin prospectors, especially that portion to the south of the Makwanakop claims on the streams which flow into the Little Usutu river.

Since the beginning of the war tin production has decreased, and, after reviewing the history of the industry, Mr. Way gives the following reasons why this situation has arisen: (*a*) Most of the known richer alluvial deposits, and those served by the intricate and elaborate system of water furrows constructed by the early tin-miners, are exhausted; (*b*) lack of interest by the larger mining

houses ; (*c*) lack of initiative in prospecting for new deposits because of poor communications away from existing roads ; (*d*) the policy of the Government until recently of not allowing alluvial mining on Native areas, as it removes the most fertile portion of the ground and results in increased soil erosion ; (*e*) control of the price of tin in South Africa at a level which does not allow of the economic working of low grade deposits under the existing increased cost of labour and materials. (Subsequently the price of tin has been allowed to rise considerably and production should be stimulated.)

At Forbes Reef the scheelite prospecting operations of Union Corporation, Ltd., were discontinued at the end of March. It is to be regretted that the results are disappointing, but Mr. Way considers that the Forbes Reef area, indeed Crown Mineral Area No. 7 generally, is a highly mineralised one, and may yet yield interesting minerals. When the opportunity offers it is intended to investigate its geology in some detail, and carry out prospecting work simultaneously. An alleged occurrence of wolframite in the Goedgegun area was examined but no tungsten minerals were found there.

During the year a considerable quantity of coarse corundum was obtained from a deposit of decomposed plumasite between Hlatikulu and Goedgegun. The crystals are up to 12 inches in length *in situ*, but on extraction they break up into flat hexagonal slabs up to 4 inches in diameter. By the end of the year the production of corundum in Swaziland had ceased, but other deposits may be discovered as the country is explored.

Clays from the valley sides of Mbabane and at Hlatikulu were examined as sources of brick-making materials, and samples were submitted to a firm in the Union for firing tests.

A detailed examination was made of Nsalitshe Hill, near Gollel, with a view to assessing the value of the coal seam and calcite veins occurring there. The hill, about 300 ft. high, consists of Karroo sandstones, grits and conglomerates, argillaceous sandstones, marls and shales, intruded by dolerite sills, one of which caps the hill. The coal outcrops on the southern side of the hill where there is an old adit. The latter was opened up, not without difficulty, and found to dip into the hill at an angle of $4\frac{1}{2}°$. It was drained for a distance of 60 ft. and revealed a coal seam 39 in. thick, consisting of an upper portion 13 in. thick and a lower portion of 20 in., separated by a 6 in. band of shale. Above a band of sandy shale, 6 in. thick, which tops the coal, lies massive gritty sandstone more than 25 ft. in thickness. Samples of the coal were submitted for report to the Institute of Fuel Research, Pretoria. The extent of the seam is unknown. Although a thorough search revealed no other outcrops of coal on the hill, this does not prove the absence of the seam on the west and north slopes, as any possible outcrops would tend to be obscured by screes. The best method of prospecting the extent of the seam would be by means of drives and crosscuts.

The calcite veins occur further west along the hill, mostly in sandstone just below the contact with a dolerite sill. Trenching has proved two veins, one over a distance of 255 ft., and varying from 3 to 13 ft. in width, the second over a distance of 67½ ft. and 8½ to 11½ ft. in width. Many other veins are probably present, and at least 10,000 tons of reef calcite are present. Four samples over the width of the reef at different points proved to be of constant composition, containing 97·4 per cent. calcium carbonate, 0·9 per cent. silica, 1·2 per cent. iron and aluminium oxides, and 0·1 per cent. magnesia. The calcite yields high grade lime and, if crushed and calcined in a special but by no means costly kiln, will yield quicklime within the grade required for the Natal sugar industry.

Near Hluti, fluorspar occurs in a silicified zone about 100 ft. wide which can be traced along the strike for more than half a mile in a fine grained granulitic granite of the Older Granite series. The wider veins, up to 18 in. wide, yield large lumps of fluorspar free from quartz which contain 97·2 per cent. calcium fluoride. Trenching, however, indicated that the veins opened up were not extensive.

A preliminary examination was made of an iron ore deposit in the mountainous country 1 mile from the Havelock asbestos mine. The ore occurs as bands, probably representing zones of enrichment, in the steeply dipping siliceous banded ironstones of the Moodies Series (Swaziland System). In composition the ores appear to vary from high-grade haematite to manganese-rich types, as shown by the following analyses. Sample A is a grab sample over a strike distance of ⅓ mile, B is over a width of 25 ft.

	Fe *Per cent.*	Mn *Per cent.*	S *Per cent.*	P *Per cent.*	SiO_2 *Per cent.*	TiO_2 *Per cent.*	Al_2O_3 *Per cent.*
Sample A	62·27	trace	0·07	0·04	3·39	1·04	4·81
Sample B	25·39	27·31	0·10	0·08	2·97	1·50	11·32

More geological information is required before it is possible to assess the possibilities of this deposit, but further work appears to be warranted.

T. D.

Preparation of Transvaal Vermiculite.—The examination of the vermiculite from Palabora in the Transvaal was commenced in 1937 by the South African Minerals Research Laboratory, and under its new style, the Government Metallurgical Laboratory, it has continued this investigation in more detail consequent on the proving of large reserves in this deposit and its opening up for development. The work has been restricted to the investigation of the best methods of dressing South African vermiculite and to the development of a satisfactory method of expanding the resultant product. The results of this work have recently been issued as a comprehensive memorandum by J. E. Laschinger, entitled " Vermiculite and the Working of the Palabora Deposit," [South African] Mineral Research Laboratory, April 1944, from which the following résumé of the preparation of the material is taken.

Since the vermiculite as mined contains admixed pyroxenite, serpentine, calcrete, and chalcedony, the first object of dressing is to remove these impurities. Secondly it is highly desirable to produce a closely-graded material as this will give the best results in its practical application and is the most suitable form for use by the consumer.

Of considerable practical importance, too, is the preparation of the vermiculite in flakes of such a size and thickness that, on exfoliation, a more or less equidimensional, i.e. cuboidal, granule will be produced. Such an equidimensional product is 25-50 per cent. less in bulk density, and layers of it have lower thermal conductivity and higher compressive strength, than unclassified material. It has been found, too, that a product of uniform size can be more efficiently and quickly exfoliated, thus increasing the capacity of the furnace, and that the resulting exfoliated product is closely uniform in its physical characteristics. Another advantage of careful size classification is that the useful characteristics are maintained in the lower ranges if this is done, thus enabling the fine material originally present, or produced during dressing, to be marketed.

The process for the production of this classified material consists first in drying the run-of-mine material from the bin, either by air-drying or in a rotary kiln at not more than 120° C., so that a product with about 3 per cent. moisture results. The dried product is then screened, the undersize from a 1 in. screen passing on to the grading operation and the oversize being reduced in a comparatively high-speed swing-hammer mill which ensures comminution rather than cleavage.

Grading is carried out by mechanically or electrically vibrated screens with square mesh cloths of apertures $\frac{1}{2}$ in., $\frac{1}{4}$ in., $\frac{1}{8}$ in. (5 mesh), $\frac{1}{16}$ in. (10 mesh), $\frac{1}{32}$ in. (18 mesh), and possibly $\frac{1}{64}$ in. (36 mesh), the undersize from the finest screen at present going to waste.

Winnowing of these grades, which may be effected separately in a single machine or simultaneously in different machines, consists in allowing the closely graded particles to fall into a horizontal gentle stream of air which carries the particles according to their density and shape to different distances and thus allows them to be collected in a row of compartments. The usual products are (1) "middlings," thick scales of vermiculite frequently interfoliated with chalcedony together with most of the massive gangue; (2) "crude longs," thick and over-average size scales of nearly clean vermiculite; (3) "cubes," practically clean vermiculite of uniform thickness which gives a cuboidal granule on exfoliation; and (4) "flakes," thin flakes of very clean mineral which might be usable without classification.

Since the bulk of the granular gangue is in the "middlings," this product is put through smooth-faced crushing rolls, rotating at slightly different peripheral speeds, which produce a shearing action.

On returning these crushed middlings to the grading circuit, the gangue is eliminated in the fines, but the cleaned vermiculite which results is not sheared to such an extent that cubic granules will be produced from it. The rolled middlings, therefore, together with the "crude longs," are then passed through a relatively slow-running hammer-mill which cleaves rather than fractures the particles and so produces them in a form suitable for yielding the required "cubes" on exfoliation. Exfoliation is best carried out at above 750° C., but although rapid expansion has been widely advocated, there is a practical limit to this rate. A high rate of heat transfer is also desirable, but excessive drying out produces a brittle product; rapid cooling has little effect on the toughness except in limiting further drying. Uniformity of product is also encouraged by treating vermiculite which is either more or less moisture free or is uniform in its moisture content.

The most suitable kiln for achieving these results is a revolving muffle divided into pockets so that each discharges its contents into a succeeding pocket before receiving a fresh charge. A kiln of this type could be made in a transportable form in order to permit its use at the consuming point, thus avoiding the high cost of transporting the bulky expanded product.

E. R. V.

Fluorspar Deposits and Production in Newfoundland.—The presence of fluorspar in the St. Lawrence district of Newfoundland has been known for over a hundred years, but mining operations were only started in 1932, and the first shipments were made in 1933. Progress has been such that Newfoundland now ranks as the eighth fluorspar producer in the world. From the commencement to the end of 1941 the total shipments of fluorspar amounted to 79,000 short tons, about half of which contained 93 per cent. CaF_2 or more, and the rest 85 to 93 per cent. During this period the St. Lawrence Corporation of Newfoundland, Ltd., was the sole producer, but more recently the Newfoundland Fluorspar Co., a subsidiary of the Aluminium Co. of Canada, Ltd., has also come into the field. A detailed study of the fluorspar deposits was carried out by R. E. van Alstine, at first under the auspices of the Newfoundland Geological Survey, and later on behalf of the Aluminium Company of Canada. An account of this work and its results has recently been published in *Economic Geology*, 1944, **39**, No. 2, 109-132.

The geology of the area is complex, the volcanic and sedimentary rocks which are of pre-Cambrian, Cambrian and probably Ordovician ages having been intensely folded and faulted, probably at more than one period, and later intruded by a batholith of alaskite granite. The fluorspar occurs in the form of veins filling fault fissures, mainly in the granite, but also in the associated dikes and sills of rhyolite porphyry and lamprophyre. Within an area of

about 20 sq. miles west and north of St. Lawrence Harbour there are at least 25 veins which are of economic or scientific interest; shafts have been sunk and underground work has been done on only 7 of these, and only 4 are being worked at present.

The veins dip very steeply, usually from 70 to 90 degrees, and they extend to a very great depth. They vary in width from a few inches to over 50 ft.; in general the higher grade veins average 4 to 5 ft. wide, and the lower grade are between 15 and 20 ft.

The fluorspar veins are regarded as epithermal and the source of the mineral is believed to have been the same magma reservoir that produced the granite and associated rhyolite porphyry and lamprophyre. The fluorspar is of many colours, yellow, red, grey, blue, purple, green, pink and white, and the gangue consists mainly of quartz with calcite, sulphides, and rarely barytes. A striking feature of the veins is banding parallel to the walls due to the deposition of fluorspar of varying colour or texture. Another type of banding is commonly found in nodules composed of differently coloured layers of fluorspar around a nucleus of breccia fragments which may be granite, rhyolite-porphyry, slate, or coarse or fine fluorspar. Large vugs, lined generally with cubes of fluorspar, often occur in the centres of veins, elongated parallel to the length.

The reserves of high and low grade fluorspar cannot yet be accurately estimated, but it seems not unreasonable to expect that they run into several million tons, and the St. Lawrence district may well become one of the foremost fluorspar producers of the world. Typical analyses of the two grades of fluorspar available are:

	CaF_2 *Per cent.*	SiO_2 *Per cent.*	$CaCO_3$ *Per cent.*	$Fe_2O_3 + Al_2O_3$ *Per cent.*
Higher Grade .	94·98	1—4	0·5—1	0·5—1·5
Lower Grade .	70·80	10—15	7—10	3—5

The mineral was at first won by surface methods only, but these were found to be unsatisfactory as water seeped through the cracks and fissures and jeopardised the whole future of the industry. Mining is now carried on underground by a form of shrinkage stoping, and operations have so far attained a maximum depth of 350 ft., but in no case has the lower limit of workable fluorspar been reached, and it is possible that the veins extend to a depth greater than 1,000 ft. The mines are still very wet, and the presence of water may well determine the depth to which mining operations may be practicable.

The original treatment methods consisted of washing, hand-picking and crushing the ore, and later, jigs and tables were employed, but more recently the St. Lawrence Corporation has installed a flotation plant, and Newfoundland Fluorspar, Ltd., ships crushed fluorspar to Arvida, Quebec, where it also is treated by flotation. This should lead to a great increase in shipments. The product is

at present shipped mainly to Canada for use in the steel, aluminium, cyanamide and hydrofluoric acid industries, and about one-quarter of the output goes to the United States. This fluorspar-producing area is one of great interest and potentiality, as there are other minerals occurring with the fluorspar which are not at present being worked; it is expected, for instance, that there may be in due course some output of lead and zinc from this district.

M. F. M. G.

Peat Industry in Quebec.—For several years past, the Quebec Department of Mines has taken an active interest in developing agricultural and fuel products from peat bogs. To promote this development, an Act was sanctioned in 1940, and revised in 1943, to authorise the government to pay annually a premium on the marketable products of any peat bog in the Province of Quebec. The main objective sought was the production and preparation of standardised peat products required by the market for use as poultry litter, stable bedding, and for soil improvement, as well as peat for fuel to meet the probability of an acute shortage of fuel for domestic and industrial purposes.

The policy of the Mines Department has been amply rewarded, and, following the renewal of interest in Canadian sources of peat occasioned by the stoppage of German and Swedish supplies to the United States during the present war, the domestic production has notably increased. In 1939, for instance, the total quantity of moss peat produced in the Province of Quebec was only 822 tons, valued at $23,914, but by 1943 it had increased to 16,116 tons, valued at $329,832. Of this latter tonnage 14,545 tons was earmarked for agricultural purposes and 1,571 tons as fuel peat. The number of employees responsible for the production was 661. At the present time there are three large plants and six of medium size in production in the province.

Details regarding the peat industry in Quebec have recently been given by H. Giraud (*Canad. Min. J.*, May 1944, pp. 283-293), who discusses *inter alia* the various methods of cutting, drying and processing of the raw material. Two illustrations are given to indicate the best practice so far developed in the various factories established in the province during recent years. Thus Excel Peat, Ltd., which began producing in 1943, and is working the Isle-aux-Coudres bog located on an island in the St. Lawrence River, 60 miles below Quebec City, operates as follows: the dried peat sods transported to the factory on sleighs hauled by a tractor are dumped into a hopper. A feeder which is driven by chain and sprocket from the shredder discharges the peat sods directly on top of the latter. A bucket elevator, fitted with sheet metal containers or cups 30 in. wide and 8 in. deep, brings the light shredded material to a shaking screen where three classes of coarseness are separated, with granulation varying from ¼ in. to 3 in. The finely shredded material up

to $\frac{1}{4}$ in. is suitable for horticultural purposes, the medium size is suitable for use as poultry litter, and the coarse is for use as stable bedding. The shaking screen consists of a wooden frame 5 ft. wide by 20 ft. long, on which wire cloth is laid. It is mounted on flexible supports, slopes down towards the discharge end, and is shaken by means of an eccentric drive. This screen is inexpensive to build and is operated at a low cost. Screens of the rotary type are no more efficient and the capital cost is higher.

From the screen, the material is dropped through a wooden chute and is pressed into bales by hand presses built locally. The shredded material is pressed into boxes made of thin wood or plywood, bound with wire or packed in cardboard boxes.

At the factory of Canada Peat, Ltd., an air suction, partial vacuum system, is applied to the transportation and classification of the shredded peat. By agitation with air, this system has secured a uniformity of product and has permitted the finely powdered particles to separate easily. The shredder is equipped for handing 160 lb. of dried peat moss per minute. At the discharging end of the shredder the pipe-hood of a suction fan takes up all the disintegrated material. The tailings, consisting of roots, pieces of wood and hard lumps, are in part separated by density.

The shredded material does not pass through the fan, which has a disintegrating effect and would cause excessive powdering. A "pull through" type of collector is located in the path of the material between the fan and the hood. The circulating air, as it enters the collector, is reduced in pressure, and the coarse material carried by the current is thus dropped. The discharge pipe from the collector empties into a rotary hexagonal screen, the coarse material is classified and falls down through chutes to the presses.

The short fibres and the light dust, with the air, escape through the top of the classifier collector to be blown by the fan into a cyclone collector. The latter effects a separation of the very short fibres and the dust.

The factory is equipped with two electric presses. The dimensions of the bales are 40 × 20 × 20 in., holding about 20 bushels of loose peat. Each press produces 250 bales per day of 8 hours. The factory is operated by electric power, and most of the machines are individually driven by suitable motors.

In the United States the price of peat moss is $1.40 per bale, f.o.b. shipping point, the average selling price of material delivered to the American jobber being $2.85 per bale, duty paid.

For over a generation numerous attempts have been made in Canada to produce peat fuel on an industrial scale, but most of these have hitherto proved unsuccessful. In 1942, however, the Quebec Department of Mines developed a satisfactory machine of simple construction and requiring a minimum of equipment for the purpose. Early in 1943, the Emergency Coal Production Board, expecting a shortage of wood-fuel, announced that financial assistance

might be made available to small enterprises for the production of peat fuel, provided a local market was available within a reasonable distance of the bog. To encourage this development, the loan of a peat machine, as developed the year before, was made available to a number of approved operators. Returns of production from eight peat fuel operators during 1943 showed a total output of 1,571 tons, the average selling price being $9.00 a ton.

Theoretically, it takes 2 lb. of peat to give the same heating value as 1 lb. of anthracite. In practice, however, 4 lb. of peat will, in mild weather, furnish as much useful heat as 3 lb. of coal when burned in the ordinary furnace and surface heaters. For open fireplaces and domestic ranges the comparison is said to be even better. Of the production of peat fuel manufactured in 1943, the larger quantity was burned as a substitute for wood fuel. Experience has shown that in the ordinary cooking stove it was as good as hardwood for ordinary purposes, and superior for cooking and baking.

The following table gives a comparison of coal, wood and peat as sources of domestic fuels.

	Unit	Weight	Storage Bulk	Calorific Power*		Price ($)	
				B.Th.U. per lb.	Relative Value.	Per Ton	Per B.Th.U.
Pennsylvanian anthracite	Ton	2,000 lb.	37%	12,900	1,808	16·50	·00127
Average hardwood dried to 25 per cent moisture	Cord	4,000 lb.	128%	6,500	956	8·70	·00134
Peat fuel air-dried to 25% moisture	Ton	2,000 lb.	62%	6,800	1,000	8·00	·00118

* *The gross heating value is for standard fuels on the market.*

E. H. B.

Magnetic Separation of Ores.—Bulletin No. 425 of the United States Bureau of Mines, which, although published in 1941, has only recently reached this country, is a well-printed and illustrated 350 page volume entitled "Magnetic Separation of Ores," by R. S. Dean and C. W. Davis. It represents the completion of a major investigation by the Bureau, whose policy is that when such an investigation has been completed, the results should be made available in permanent form, although many of the sections have previously appeared at different times in mimeographed form.

The science of applied magnetism is as highly and satisfactorily developed as any branch of physics. A surprisingly large number of patents have been issued, covering mineral separations by means of nearly all magnetomechanical effects. Magnetic separators have an important rôle in the separation of constituents that are naturally magnetic, or can be treated to assume ferromagnetic properties, in

such widely divergent industries as those involving the treatment of ores, clay slip, slag, cork, rubber, shellac, sand, and plant wastes; even foodstuffs and other agricultural products may be purified by this means.

The work opens with a number of chapters on basic theoretical considerations and recent research related thereto: the physical basis of magnetic-separation processes; laboratory studies of magnetic minerals, including the construction and operation of a magnetic balance, apparatus for determining magnetic constants of mineral powders, magnetisation curves for magnetite powders, coercive force of magnetite powders, development and application of the coercimeter, new separators based on coercive force and remanence, effect of lattice discontinuities on the magnetic properties of magnetite, heat treatment for magnetic separation, equipment used for laboratory testing, results of laboratory tests.

These sub-headings of the first two chapters, which occupy 168 pages, indicate the wealth of theoretical matter introduced at the outset, and it is by no means restricted to the earlier part of the publication, which next proceeds to review the development of the art of magnetic separation as shown by United States Patents. These patents are classified and listed in some detail.

To many, Chapter IV, which devotes 40 pages to consideration of important types of separators, will be of special value, while Chapter V, which deals with the applications of magnetic separators, is no less important. In the course of its 100 pages, Chapter V deals in some detail with a considerable number of instances, drawn from all parts of the world, of successful, large-scale application of magnetic separation. In later chapters a number of other related topics are treated.

It is evident therefore that this comprehensive treatise is scarcely intended to be an introduction to the subject of magnetic separation suitable for the general reader. It will be most useful to those with a knowledge of physics and some experience of magnetic separation who desire to become better acquainted with recent fundamental research on magnetism and its recent or potential applications to industry. The volume will also be found of special value in ascertaining which of the numerous types of separator available is likely to be the best suited to a particular case.

Those concerned with the problem of making an exceptionally clean separation on a laboratory scale of finely divided magnetic and non-magnetic material will be interested in the method of demagnetisation suggested on p. 15. By utilising a rotary switch with a shunted condenser in the power line that energises a direct current magnetic separator, a high-frequency damped oscillatory discharge can be made to alternate with the normal functioning of the electromagnet. The effect of the high-frequency discharge is to convert the magnetising coils of the electromagnet into demagnetising coils. Small-scale tests have shown that when the switch

operates slowly magnetic material supported below a pole of the magnet is cyclically picked up, held, demagnetised, and dropped. If, however, the speed of the rotary switch is adjusted properly, the particles are picked up, momentarily demagnetised, and allowed to drop a short distance in this condition, liberating entangled non-magnetic waste matter, which continues to fall while the magnetic particles are again pulled back towards the magnet pole. Since this action can be repeated as long as desired, an exceedingly complete separation should be possible.

A. W. G.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

British Coal. Its Selection, Purchase and Utilisation for Inland Purposes. By H. L. Pirie, M.I.Mech.E. Pp. viii + 168, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1944.) Price 15*s*.

The scope of this small volume is even wider than its title suggests; in fact, it deals with most matters relating to coal, fuels derived therefrom, and their correct application and efficient utilisation. Many allied problems are also touched upon in so far as they apply to this country. The British coalfields are dealt with in 10 pages, but there is no account of mining methods and considerations, either underground or opencast.

The book would appear to be intended in the main to assist the general reader in the characteristics of British coals, the selection and purchase of grades best suited for the purpose intended, and their correct method of utilisation. Certain war-time measures are also included.

The style is generally most succinct, frequently almost taking the form of notes. This, combined with a wholesale use of abbreviations has enabled a great deal of useful information to be compressed into 168 pages and is doubtless justified in a war-time publication of a handy, semi-popular type.

For those desirous of giving further attention to particular aspects, short bibliographies are appended to each chapter. It is particularly unfortunate that while the bibliography on the British coalfields (Chap. V) tells one where a complete list of publications of the Department of Scientific and Industrial Research is obtainable, no reference is made in the bibliography to the invaluable and most comprehensive series of memoirs and large-scale maps published by the Geological Survey.

A. W. G.

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Compiled by Miss M. F. M. Garratt, B.Sc.

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THE LATE COLONEL THE HON. DENEYS REITZ, HIGH COMMISSIONER IN LONDON FOR THE UNION OF SOUTH AFRICA

THROUGH the death on October 19 of Colonel the Hon. Deneys Reitz, this Institute has lost a staunch and valued friend. As a boy of twelve, Col. Reitz first visited the Institute in 1894, less than a year after its official opening by Queen Victoria. Soon after his arrival in London to assume the office of High Commissioner for the Union, Col. Reitz paid a second visit to the Institute; and later, in a goodwill message in celebration of the 50th anniversary of its inauguration, he wrote: "As a South African I would like to say how much your African exhibits are admired by every visitor from the Union. Indeed, the panoramas, the models, and the photographs and pictures of South African scenes are so lifelike and real as to render us positively home-sick for the sunshine and the wide horizons of our own country. To-day, with the Empire once more facing the powers of darkness, the need for stressing the determination of the free nations of the earth to maintain their liberties intact, becomes greater than ever and the value of the Institute's mission in creating a better understanding of our aims and ideals becomes the more important."

As a member of the Board of Governors of the Institute Col. Reitz gave continuous and valued support and advice in the maintenance of old and the development of new contacts with the Union. His loss is deeply deplored by all associated with the work of the Imperial Institute.

H. A. F. L.

PLANT AND ANIMAL PRODUCTS

ARTICLE

PAPER-MAKING MATERIALS OF THE BRITISH EMPIRE[1]

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Introduction

This lecture is a review, necessarily brief in view of the time at our disposal, of the principal materials to be found in Empire countries which are being employed for the production of paper, or which may be considered as new materials for that purpose, and of the prospects of expanding the Empire pulp industries. With processes of manufacture of pulp and of paper we are not concerned, but in order that we may be quite clear as to what is involved in the manufacture of paper and understand references to it made in respect of the materials reviewed, it is worth while to run quickly through an outline of the subject.

Paper consists of vegetable fibres or aggregates of fibres felted together to form a web, together with such quantities of fillers, size, pigments, etc., as may be necessary to produce desired effects, for instance, to receive writing ink without feathering.

The production of paper embraces two distinct operations, firstly, the production of pulp or " half stuff " from wood, or other materials, and secondly, the making of the pulp into paper. Pulp manufacturers are not always paper makers, but many concerns combine the two operations.

Concerning the production of pulp, this may be by chemical processes or by mechanical means. For the chemical pulps the sulphite, sulphate or soda processes are the major ones employed, the choice depending on the nature of the raw material and the kind of pulp required. In each case the object is the same, (*a*) to dissolve the cementing substances and separate the material into its ultimate fibres, and (*b*) to purify the fibres, or pulp, by the removal of non-cellulosic constituents. Some grades of pulp are bleached. Mechanical pulp is made by grinding softwoods, and in this case aggregates of fibres are produced which being wide in relation to length lack the strength of chemically separated fibres. In this process damage to the fibres is inevitable. Mechanical

[1] Lecture delivered before the Royal Society of Arts, March 21, 1944; printed by permission of the Society in whose *Journal* it appeared in slightly abridged form.

pulp is in fact ground wood containing practically all the ingredients of the original timber, and in this respect is quite distinct from chemical pulp which is composed more or less of pure cellulose. Mechanical pulp is the cheapest to produce and constitutes the bulk of the pulp in newspaper or newsprint.

The making of paper is a very technical operation and employs some of the most highly developed machinery in modern use. Briefly, the pulp received from the pulp mill after suitable preparation is fed on to a moving wire belt at the wet end of the paper machine, where the water drains away, and the web of fibres after passing through pressing rollers is carried on and finally dried by passage around hot cylinders.

The World Position of Pulp Production

The countries of the British Empire contain vast stores of paper-making materials of all kinds, or possess potentialities for their cultivation. The utilisation of these materials for commercial purposes is, however, a matter that is governed by several factors, economic and technical, which will be discussed more fully later, but the net result of all those considerations may be summed up in the statement that coniferous woods at the present time are the chief paper-making material of the world. In fact, about 90 per cent. of the paper produced is made from wood, the bulk of which is coniferous, while the amount of hardwoods used is only a few per cent. The remaining materials employed are rags, esparto grass, straw, bamboo, sabai grass, old ropes, fibres and waste paper. Any material which is brought under consideration as a major source of paper pulp is measured against the yard stick of the softwood pulp industries.

Technically, coniferous wood is the material *par excellence* for paper-making on account of the unique suitability of its fibres in length and other properties. It responds to different pulping processes and different methods of treatment in manufacture, yielding products as diverse in character as blottings and greaseproofs, newsprint and high-class bonds, tissues and krafts. No other material approaches it in these respects.

In order to understand the markets of the world in which Empire materials have to compete, it is necessary to glance at the existing position as regards production and consumption.

The key to the position being the coniferous woods, we must look for the countries possessing resources of these woods. These countries have a share of the northern coniferous forest belt. In the Southern Hemisphere there is no coniferous belt to correspond to that in the north.

From this picture emerges the fact that North America, Scandinavia and Russia, with their wealth of conifers, possess a great advantage over other countries. The next point to consider is availability. Russia's forests are, to a large extent, remote from

transport facilities, and at present her productive areas are required to supply her own needs. Scandinavia and North America with extensive waterways and abundant cheap water power, however, represent the sources to-day of the bulk of the world's paper and paper products.

The following table shows the total production of wood pulp in various countries.

World Production of Wood Pulp
(Thousands of long tons.)

	1930.	1932.	1934.	1936.	1937.	1938.
United States	4,134	3,357	3,961	5,103	5,869	5,298
Canada	3,232	2,378	3,247	4,005	4,591	3,275
Sweden	2,409	1,965	2,824	3,105	3,468	3,013
Germany	2,055	1,682	1,979	2,330	2,524	2,504
Finland	1,059	1,243	1,543	1,945	2,097	2,077
Norway	917	886	967	976	1,080	893
Japan (including Korea and Sakhalin)	636	564	705	773	824	(a)
U.S.S.R.	378	429	517	689	728	(a)
France	143	182	276	337	349	337
Austria	312	279	314	331	407	377
Newfoundland	257	235	274	282	315	238
Czechoslovakia	308	285	320	282	367	(a)
Poland	106	92	121	142	171	184
Italy	130	123	111	137	181	183
United Kingdom	101	91	108	115	120	115
Netherlands (b)	91	95	99	106	119	103
Estonia	73	75	85	88	85	90
Switzerland	76	65	76	71	89	74
Lithuania	55	39	55	58	65	(a)
Roumania	42	31	45	50	56	81
Latvia	24	15	23	32	35	40
Other Countries	93	98	114	104	74	(a)
Total	16,631	14,209	17,764	21,061	23,614	(c) 18,882

(a) *Not available.* (b) *Includes straw pulp.* (c) *Incomplete.*

Outlook for New Materials

Having seen the outstanding value of softwoods for paper-making, and the position of the countries possessing those resources, let us consider the question of introducing new materials from Empire or other sources to the United Kingdom. It is at once clear that this market is dominated by a ready supply of suitable pulps from a source close at hand, Scandinavia, and any material which comes under consideration for import into the United Kingdom will have to compete in technical properties, cost of production and cost of transport with the Scandinavian pulps.

The present position is that apart from esparto grass and very small amounts of fibrous materials, required for their special characteristics, and amounting in all to a small fraction of our import, there is no material which has been able to contest the situation.

Newsprint is imported from Canada and Newfoundland, where it is produced under exceptionally favourable conditions.

Canada and Newfoundland are the only two Empire countries which have yet established an export of pulp or paper made from local material.

Although the outlook for placing new Empire materials on the United Kingdom market is unfavourable, except perhaps for the production of speciality papers, there is, however, a very important field of development for the paper-making materials occurring in Empire countries, namely, in supplying the local demand for paper, where, as in the case of the Dominions, this demand is sufficiently large to warrant the establishment of local mills. This would be followed by an export trade if conditions permit. In this connection we shall see that India has led the way, and Australia has recently made exceptional strides.

The Present Position of Pulp Production in Empire countries

The position we will consider is that of 1938, with reference, where necessary, to subsequent permanent modification, but generally ignoring the abnormal conditions of the present war years, for which, furthermore, full details, in many instances, are not available, or are withheld for security reasons.

We commence with the most important producer, and that is Canada, whose pulp production is the second largest in the world, while in newsprint output she occupies the premier position. In the Empire no other country apart from Newfoundland approaches Canada in importance as a source of paper pulp.

Canada.—The production of pulp and paper constitutes a major industry in the Dominion. It occupies first place among Canadian manufacturing industries. The development proper in the manufacture of paper started about 1880, when the utilisation of wood pulp in place of rags became commercially possible. The great expansion in the Canadian industry has mainly followed the great increase in the world demand for newsprint during the present century, and particularly since 1920. The Canadian production of wood pulp is only exceeded by that of the United States, but the production of newsprint in Canada is nearly three times that of the United States, which was previously the world's largest producer.

The wood pulp production is about three to four million tons, manufactured chiefly from the soft (coniferous) woods, spruce and balsam fir, with lesser quantities of hemlock, Jack pine, poplar and other kinds, by mills, most of which are situated in Eastern Canada, principally in Quebec and Ontario, and also in British Columbia, Nova Scotia, New Brunswick and Manitoba. In 1938 there were 75 mills producing pulp. Of these 48 also made paper. In addition, there were 24 mills making only paper. The industry is mainly a newsprint production, about 80 per cent. of which in 1938 was bought by the United States, the world's largest newsprint consumer.

The enormous size and importance of the industry will be appreciated from the following tables:

CANADA

PULPWOOD PRODUCTION IN THE YEAR 1938

	Quantity in cords.	*Value in £.*
Total cut	6,306,747	10,909,000
Home consumption	4,588,156	8,183,000
Export	1,752,259	2,768,000

WOOD PULP PRODUCTION IN THE YEAR 1938

	Total production.		*Export.*	
	Quantity in long tons.	*Value in £.*	*Quantity in long tons.*	*Value in £.*
Mechanical	2,198,212	7,960,000	110,897	591,000
Sulphite, bleached	272,173	3,819,000	211,105	3,195,000
,, unbleached	513,628	3,863,000	88,246	821,000
Sulphate	200,922	1,870,000	68,112	900,000
Screenings	72,750	138,000	7,353	20,000
Other pulp	17,127	186,000	8,963	100,000
Total	3,274,812	17,836,000	494,676	5,627,000

PAPER AND BOARD PRODUCTION IN THE YEAR 1938

	Total production.		*Export.*	
	Quantity in long tons.	*Value in £.*	*Quantity in long tons.*	*Value in £.*
Newsprint	2,382,958	21,723,000	2,164,870	21,229,000
Other paper	199,602	5,136,000	—	748,000
Paper board	318,653	3,914,000	64,067	927,000
Total	2,901,213	30,773,000	—	22,904,000

In 1938, 67 per cent. of the wood pulp produced was by the mechanical process, and 24 per cent. was sulphite pulp.

Canada's high place in the world's paper industry is, of course, due to her share of the earth's northern belt of softwood forests, combined with the existence of excellent and extensive sources of water power, and facilities for water transport. The harnessed hydro power is over eight million horse-power, equivalent to 40 million tons of coal per annum. The striking advantage of this national asset is easily recognised.

In order to convey some idea of the forest wealth of the Dominion, a few details are summarised in the following tables from figures quoted by the Chief Trade Commissioner:

CANADA'S FORESTS

POSITION IN 1938

Land area of the Dominion	3,466,566 sq. miles
Area covered with forest	1,223,552 sq. miles

Estimated stand of wood	273,650,000,000 cu. ft.
Productive forest area	770,000 sq. miles
Standing timber	170,144,000,000 cu. ft.
Timber cut for use (in 1937)	3,000,000,000 cu. ft.
Timber destroyed by fire (annual)	564,000,000 cu. ft.
Timber destroyed by disease, etc. (annual)	700,000,000 cu. ft.

DISTRIBUTION OF FORESTS
(In percentages.)

In :—	*Total standing timber.*	*Present productive area.*
Eastern Provinces	67	66
Prairie Provinces	15	22
British Columbia	18	12

The foregoing details represent the position in 1938, and the areas classed as non-productive in that year were unusable through inaccessibility or other causes, but much of it will probably become productive at a later date.

It will be seen that the annual withdrawal and loss to the forests is about 4,000 million cu. ft. of timber a year, of which 800 million is the present rate of absorption for the wood pulp industry, while the productive stand is about 170,000 million.

It has been alleged that Canadian forests have been despoiled for the profit of newsprint concerns, and in the past, no doubt, prodigal use was made of the seemingly inexhaustible resources, but to-day the Dominion is aware of the value of re-afforestation to maintain her resources of constructional timber and pulp-wood. A complete picture of the situation is difficult to obtain, but allowing for increases in the demand for building timber as well as for pulp-wood, it is considered that a constructive forest policy has plenty of time in which to balance annual depletion with annual growth, if this is not already the case, before serious inroads are made on the capital.

Newfoundland.—This country possesses large forests of spruce and balsam fir, which provide the raw material for her staple industry, paper-making. In 1938 there were only two mills operating, producing 282,000 tons of newsprint, which was exported entirely to the United Kingdom and the United States, with the exception of a thousand tons to India. This export of paper was worth £2,669,000 and represents about 40 per cent. of the total exports.

There is no export of wood pulp, but pulpwood is exported, the quantity in 1938 being 60,000 cords, valued at about £130,000.

There are now three mills operating respectively at Grand Falls, Bishops Falls and Corner Brook, producing newsprint, sulphite pulp and baled ground wood, while a fourth mill, with a capacity of 100 tons a day, makes sulphite pulp.

India.—The paper industry of India has been long established, the first mill commencing operation as early as 1825. In 1870 the

first mill of importance started production. This was followed at intervals by other mills, and by 1900 the paper produced in India amounted approximately to 20,000 tons. In 1925 there were nine mills in production. Up to this time the staple indigenous raw material for pulp production was sabai grass (*Ischæmum angustifolium*), common in Northern and Central India. Although India has a large population the paper demand is relatively small. Nevertheless the country's requirements represent a fair-sized industry, and in order to increase the production of home-made pulp it was necessary to look for other material than sabai grass, the supplies of which were limited and not capable of further expansion. Through the outstanding work of Raitt, bamboo was shown to be a suitable material to meet the local demand in many respects. A protective tariff, imposed in 1925 on imported paper which competed with Indian-made sorts, greatly assisted the paper industry and enabled bamboo pulp to be developed as the main local material. A further tariff in 1932 on imported wood pulp had the effect of countering the increased use of this material. The mills then began to increase the production of bamboo pulp, which had already established itself as suitable for writing, printing, bank, ledger and other classes of paper. Sabai grass, having its own characteristics, is retained for some classes of paper, and is the chief material employed in the United Provinces and the Punjab, where adequate supplies of bamboo are not available. Otherwise bamboo is the main indigenous material employed. In the years from 1925 to 1931 the average annual production of bamboo pulp was about 2,000 tons, grass pulp about 10,000 tons, imported wood pulp 17,000 tons. By 1939 the production of bamboo pulp had risen to about 33,000 tons, sabai grass pulp amounted to 22,000 tons, while the imported wood pulp had fallen to approximately 13,000 tons.

There were in 1939 some 12 paper mills operating in India, producing 73,000 tons of paper, as compared with 27,000 tons in 1925.

Recently it has been shown that kraft pulp can be made from bamboo, and production on a commercial scale has commenced.

Attention has been given to materials for mechanical pulp. Projects for the establishment of newsprint mills in Kashmir and Tehri-Gahrwal States, employing local fir and spruce, are under consideration.

India imported prior to the war about 35,000 tons of newsprint, some 25,000 tons of paper board, and about 40,000 tons of other kinds of paper.

Australia.—The paper manufacturing industry of the Commonwealth is well established, but until recently it operated entirely on imported pulps, from which were produced approximately 72,000 tons of paper and board, valued at £1,500,000 per annum. Since 1938 rapid strides have been made in the supply of pulp from home-grown materials, and several important pulp mills have come

into being. For many years the Australian paper industry in co-operation with the Council for Scientific and Industrial Research has been investigating local materials, particularly eucalyptus woods, as sources of paper pulp. The utilisation of these woods presented problems which have necessitated modification of the usual pulping processes, and the important developments which have now taken place are the outcome of sustained effort over a period of some 20 years.

The mills making pulp which are now operating are as follows:

A large pulp and paper mill at Burnie in Northern Tasmania using the local eucalyptus woods (*Eucalyptus gigantea, E. viminalis* and *E. amygdalina*) to produce a wide range of printing and writing papers. The process employed for pulping is a modified soda method. The project was at first to produce 20,000 tons of paper a year, and then gradually to increase its capacity. Pulp production commenced in 1939, and by 1942 the mill was turning out printing and writing papers at the rate of 21,500 tons a year, of which 90 per cent. was eucalypt pulp, the remainder being imported sulphite pulp.

At Boyer, 20 miles from Hobart, is a mill of outstanding interest, since it produces newsprint from local eucalyptus wood, chiefly swamp gum, *Eucalyptus regnans*, and is the first commercial plant to manufacture mechanical pulp from hard wood. The furnish consists of 83 per cent. eucalypt mechanical pulp, and 17 per cent. imported sulphite pulp. The present installation was designed to produce 27,000 tons of newsprint a year, but a second unit is contemplated to double the output, and ultimately it is hoped to increase production capacity to 108,000 tons.

The erection of the Boyer Mills was begun in 1939, and May 12, 1941, represented a notable landmark in Australia's industrial history; the evening newspapers in the capital cities of Australia were printed for the first time on paper made in an Australian newsprint mill and containing Australian-made mechanical pulp from native hardwood trees.

A mill at Maryvale, Victoria, commenced production in 1939, after a pilot mill had functioned since the previous year. The mill produces kraft pulp mainly from eucalyptus wood, and to a smaller degree from pine, provided according to agreement, from Victorian forests by the Forests Commission. The output of pulp is now about 30,000 tons a year, and is converted into wrappings and boards of various types. The company concerned is also working up waste paper and rags in addition to continuing on an increased scale its old-established production of strawboard.

Production commenced in 1942 at a new mill near Millicent, South Australia, of cardboard from waste paper, but the factory is designed to convert pulpwood thinnings supplied on contract by the government, from the neighbouring forests of Mount Barr and Penola, into kraft pulp and boards of various types. The wood is

from the very extensive plantations of *Pinus insignis* which have been established. It is estimated that these plantations should be capable of yielding about 50,000 tons of wood a year which would be suitable for pulping. The production of boards in 1942 was at the rate of 5,000 tons a year.

Another mill is situated at Raymond Terrace, New South Wales, for the production of wood pulp, of which details are not available.

With regard to the size of the Australian market, before the war the normal consumption was 55,000 tons of writing and printing papers, while the newsprint requirements were 150,000 tons.

New Zealand.—At present there is only one mill in New Zealand manufacturing paper pulp, and that is the mill at Whakatane in the Bay of Plenty. This mill is producing mechanical wood pulp, mainly, it is understood, from the locally-grown conifer, *Pinus insignis*. The ground wood pulp is employed for the manufacture of paper board. The output of pulp at this mill in 1939 was approximately 10,000 tons, but it is understood that the yearly quantity is capable of being increased. A second mill at Mataura in the South Island has been making paper from rags and imported pulp for many years, but is not a producer of pulp.

A third mill, at Penrose in Auckland Province, designed to use the sulphite process for converting *Pinus insignis* wood into pulp, is understood to have started the production of a wall board.

In 1938 New Zealand imported newsprint to the value of £527,000, and paper, cardboard, etc., valued at £1,540,800. In addition to this, wood pulp was imported. The normal peace-time requirement of New Zealand in pulp of all sorts is of the order of 100,000 tons. Thus there is scope for a pulp production industry employing local materials on a fairly considerable scale, to supply at least home needs. The replacement of imported paper and pulp products by home manufacturers would entail not only increased local pulp production, but a substantial extension of the Dominion's paper manufacturing capacity.

Union of South Africa.—The first mill in the Union for the manufacture of pulp was erected in 1938, at Geduld on the East Rand, Transvaal. The establishment is on an extensive scale, and is of considerable interest and importance from the point of view of South African enterprise, and from the fact that the Pomilio soda-chlorine process is employed, a process which has been introduced in recent years. The raw materials employed are wheat straw, the wood of *Pinus patula*, and wattle wood, and the finished products are writing and printing papers, and specialised board. The present production is approximately 14,000 tons of paper and 2,000 tons of board per annum, but plans for considerably increasing the output are well advanced.

Although the Geduld Mill is the first, and so far the only, South African plant to make pulp, a mill has operated since 1920 at Klip

River, Transvaal, producing kraft papers and industrial wrappings from imported wood pulp and local waste paper.

There is also a mill at Durban making carton, box and other types of industrial boards from waste paper and imported pulp.

Further mills have been under consideration to utilise thinnings from the *Pinus patula* plantations, Eastern Transvaal, and *P. pinaster* plantations, Cape Province, but the projects have not yet come into being.

With regard to the Union's requirements, an idea may be gained of the consumption of paper from the following import figures for 1937. In that year the Union imported 42,000 tons of newsprint, 34,000 tons of other printing papers, and 37,000 tons of wrapping paper, in addition to which large quantities of paper board and other paper products were imported.

The United Kingdom.—This country has no softwood forests or other sources of material to compete with the Scandinavian and North American conifer stands. Consequently for our large requirements in paper we import about 1,600,000 tons of wood pulp, almost entirely from Scandinavia, only 1 per cent. being obtained from Canada and Newfoundland. The pulp made in the United Kingdom is from imported pulpwood, esparto, straw, rags and manila and other fibres. Since imported wood pulp constitutes 90 per cent. of the raw material used for paper, it will be seen that the quantities of the other materials employed are relatively small.

There are three mills in this country making pulp from imported wood, one by the mechanical process and two by the sulphite method. Esparto pulp is made on a fairly large scale, about 300,000 tons of the grass being imported annually. This is a relatively easy material to convert into pulp, which is required chiefly in the furnish of book and other printing paper, providing bulkiness and other desirable properties.

In addition to the 2,000,000 tons of paper and board manufactured in the home mills, the United Kingdom still needs further large quantities to satisfy her enormous demands. To this end approximately a further 1,000,000 tons are imported, the chief item being about 500,000 tons of newsprint from Canada and Newfoundland.

The above description represents conditions in peace time just prior to this war, when overseas supplies were unhindered. By force of circumstance paper makers have had to look more and more to home-produced materials in these last few years, and with normal conditions entirely disrupted home-grown straw has become the chief material, apart from waste paper, for our paper production.

New Materials and Development of Empire Pulp Production

We will now consider the possibilities of expansion of the existing industries and the utilisation of new materials occurring in the Empire.

In the first place, let us look at the probable position of the producing countries in the future.

There is every reason to expect that Scandinavia, where efficient re-afforestation schemes ensure the equilibrium between cutting and reproduction, will be able to continue more or less indefinitely the pre-war rate of supply to the United Kingdom. The Canadian industry is, however, capable of further expansion. Although shortage of paper-making materials is a fear that perennially seizes the paper world, no real grounds for such an attitude with regard to the near future have been established. Nevertheless, it is sound policy to be prepared and the possibilities of new and alternative materials for consumption in the United Kingdom should be considered, on economic and political grounds.

Whether or not the profitable marketing of a new material in the United Kingdom can be accomplished, there is, as already stated, a clear road for development in overseas countries which are placed at a long distance from Scandinavia or North America, or the paper mills of the United Kingdom.

We can therefore decide that the utilisation of new materials for pulp making should be considered throughout the Empire in the first place for local use, and secondly, where conditions are favourable, for export to a suitable market.

In India, Australia, South Africa, and New Zealand the local demand for paper and paper board is large enough to maintain a home industry, but in the Colonies generally production of pulp for export is the only possibility.

There are many factors to be taken into account in considering the establishment of a new paper pulp industry, and these should receive the closest examination before a decision is made. Any material to be of value for pulp making must be available in large quantities. The smallest mill which, in most circumstances, it would be profitable to erect must have an output capacity of the order of at least 10,000 tons of pulp a year, for which would be required some 25,000 tons of raw material. The cost of collecting the material and transporting it to the mill must be sufficiently low. It must also be definitely established that the supply of the raw material in the requisite quantity can be maintained for a sufficient number of years ahead, to make the enterprise profitable. If these conditions can be fulfilled and laboratory investigation has shown the material to be promising, then large-scale trials should be proceeded with. Yields must be determined, and the most suitable method of pulping worked out. If pulp of suitable quality can be produced, and the cost of production is known, then it remains to ascertain if the price will enable the product to compete successfully on the nearest overseas market or further afield. If the home demands and industrial conditions are suitable for the local production of paper or paper board, the cost of the pulp delivered at the paper mill as compared with that of imported pulp will be the deciding factor.

A pulp mill to be successful must be conveniently situated in regard to the availability of supplies of chemicals and of fuel or electric power, and, in particular, a good water supply must be available, since water in large quantity is essential in the manufacturing process.

Export of the raw material itself, although possible, would probably be ruled out by high freight, unless a consuming country were situated close at hand.

The new materials to be considered for utilisation fall into three groups: (1) woods; (2) bamboos, grasses and reeds; (3) miscellaneous materials. They will now be reviewed in that order.

Woods.—With regard to wood, as we have seen, wherever forests of softwood, in sufficient quantity, and in suitable positions occur, the establishment of a wood pulp industry presents no problem. Apart from North America the British Empire contains no area of natural softwood forests sufficiently large to support a pulping industry. But there are stands of hardwood trees and of resinous trees in Empire countries extensive enough for commercial development, and to these materials attention of late years has been directed, not only in the lands of the Empire, but in the United States, and in Germany in particular.

The hardwoods, poplar and aspen, have been used in the United States for many years to a small extent, providing pulp of inferior strength, made by the soda process. This has been employed as a filler and for its property of imparting opacity and bulkiness to the paper. Whereas the fibre length of softwoods is about 3 mm., that of hardwood fibres is only half that figure.

Another disadvantage attending hardwoods is the fact that while the conifers may occur in relatively pure stands, that is to say, large areas of the forest are almost entirely spruce or balsam fir, the hardwood trees generally occur in very mixed forests, and in considering their utilisation the number of the kind concerned, per acre of forest, and the trouble of removal, must be taken into account.

When we remember that tropical forests may contain a very large number of different kinds of trees to the acre, the purity of the stand when considering mixed forests is a very important factor. Large areas entailing ever-increasing haulage distances might be required to provide the tonnage necessary for the economic running of the mill, and might render the cost of collection prohibitive.

Another advantage which spruce possesses is the uniform character of the wood throughout the trunk and of the spring and summer growths, a property shared also by balsam fir and the two Canadian hemlocks, while in broad-leafed trees the material from different situations in the trunk varies in density and character from the paper-making point of view, and some of the pines show seasonal variation.

The pulp manufacturer requires a supply of uniform raw material

because the digestion process which he employs will be worked out in detail to suit a given material. If the material varies beyond certain limits, which are fairly narrow, the digestion conditions may be insufficient or too drastic, giving defective pulp on the one hand or loss of yield and waste on the other. It is, therefore, seldom found that the wood from different trees can be cooked together, and the question of separating the kinds in felling, transport, and treatment at the mill will have to be considered.

In spite of these drawbacks, great progress has been made in the employment of hardwoods and resinous woods for paper production. In America, where hardwood species dominate the forests of the South, New England and the Lake States, birch, beech, maple, chestnut, cottonwood and gum have in recent years been used in addition to aspen and poplar. In Germany the use of beech has been developed, more especially for rayon and staple fibre industries.

The relatively low cost of hardwoods, on account of their higher density, makes their use attractive, and in the case of mechanical pulp this offsets the greater power consumption on grinding.

The utilisation of pine wood, of which the world contains large forests, has appealed for notice, and the problem here is to overcome the objectionable content of resin. For this purpose the soda or sulphate processes with their alkaline action have been necessary, kraft pulps being produced. In recent years the sulphite process has been modified in its application to Jack pine, and this resinous wood is now employed for sulphite pulp in America and Canada, so far on a small scale.

These resinous pine woods have also been used in making mechanical pulp, but so far only on a limited scale commercially.

Although Canada is a land of plenty in respect of spruce forests, nevertheless there are vast forests of birch and maple in Eastern Canada, and hardwood utilisation is therefore of interest to the Dominion, if not to-day, perhaps to-morrow.

These recent advances in the production of pulp from hardwoods and resinous woods is of great moment to Empire countries which have no softwood forests of exploitable dimensions.

In Australia we have already seen that the commercial production of mechanical pulp from a hardwood, a eucalyptus tree, has been achieved, and eucalypts and *Pinus insignis* pulped by an alkaline process.

In New Zealand *Pinus insignis* is being used for the production of mechanical pulp, and is to be used for sulphite pulp, but New Zealand has other woods which have been shown to be suitable for paper-making. Some fifteen different home-grown woods were investigated in the years following the last war, the question of the utilisation of waste wood from the timber industry being concerned. Part of this work was carried out at the Imperial Institute, the following eight timbers being examined: four species of *Fagus*

(Beech), *Pinus laricio* and *P. insignis*, *Weinmannia racemosa* and *Beilschmiedia tawa*. All these woods proved capable of yielding paper pulp of satisfactory quality. Work carried out at the Forest Products Laboratory, Wisconsin, with six New Zealand woods, showed, amongst other things, that a high-grade newsprint could be made with insignis pine sulphite and tawa sulphite and ground wood.

In South Africa thinnings in sufficient quantity are available from plantations of pine established primarily for timber supplies. Work at the Imperial Institute and in South Africa has shown that *Pinus patula* and *P. pinaster* are suitable for pulp production.

Another tree, *Eucalyptus saligna*, has been extensively planted in recent years in the Transvaal and Zululand for the provision of mining timber, and laboratory trials have shown the young wood to yield a short-fibred pulp of satisfactory quality, which might be considered for commercial production. A sound line of development in South Africa would appear to be the pulping of surplus plantation timber provided the site in the forest area fulfils the requirements for a pulp mill, and is within economic distance of the paper mill. The radius of distribution of the latter would obviously have a profitable limit.

Another aspect of wood utilisation is presented by the mixed forests of British Guiana, British Honduras, Trinidad, Nigeria and Rhodesia. A great number of woods, both hard and soft, have been examined at the Imperial Institute from these forests, and many of them were found to give pulps of varying character suitable for paper-making. For such sources of pulp it is very important to consider the market to which the product will be sent, and the competition it will have to meet.

An essential to calculating the possibilities of running a pulp mill on the produce of any given forest area is a survey of that forest, which generally is a long and expensive piece of work, and in very few instances has yet been thoroughly carried out. It is obviously unwise to sink capital in the erection of pulping mills, if it has not been definitely ascertained that within economic transport distances the forest contains sufficient trees of the kind required to keep the mill supplied continuously. In this connection the possibilities of regeneration must be taken into account, and the cycle of reproduction and cutting, which may be 15, 30 or 60 years, worked out.

It cannot be emphasised too strongly that the setting up of a pulp mill, with the large amount of capital required, needs very careful calculation and forethought, and although the raw material may be excellent for paper-making, many other conditions must be fulfilled before the enterprise has a chance of success. Nevertheless, of all the materials capable of yielding paper pulp, wood is the most economic one for the bulk of the requirements, since per acre it yields the greatest weight of pulp.

There is no likelihood in the near future of supplies of pulp from these Colonial sources successfully competing on the United Kingdom market with the Scandinavian products, and the production of pulp for other markets is problematical.

On the other hand, as already stated, the line of development for Australia, New Zealand and South Africa in producing paper pulp from home-grown trees to supply the local paper and board requirements, has encouraging prospects.

Bamboos, grasses and reeds.—The next category of raw materials to be considered comprises bamboos, grasses and reeds.

India, as we have seen, has led the way in using bamboos on a commercial scale, and her pulp industry based on this raw material is well established, thanks to the work of Raitt in demonstrating how bamboos could be profitably converted by a fractional digestion method to good quality pulp. At the Imperial Institute bamboos from East Africa, the West Indies, Malaya and other places have been investigated and shown to be technically suitable for pulp production.

In Trinidad a small mill was established, running on local bamboos, and has operated intermittently.

Bamboos constitute an attractive source of paper pulp which is suitable for high-class book and writing papers, and for mixing with other types of pulp. The establishment of mills running on bamboo has to be viewed in the light of competition with wood pulp, and, apart from India, where they operate under a tariff protection, such mills have not come into operation.

Raitt's review of the possibilities of producing pulp from the extensive resources of bamboo in Burma has pointed out the prospects of that country as a source of pulp for export.

One feature of advantage in respect of bamboos is their quick rate of growth and regeneration. They can be cut every four years for the pulp mill. This might be given consideration when planning the exploitation of a tropical forest for pulp production. Certain cut-over areas might be brought into quick bearing again with bamboo.

Many grasses and reeds from South Africa, Nigeria and other Empire countries have been examined at the Institute as paper-making materials, including Lalang (*Imperata arundinacea*), Spanish Reed (*Arundo donax*), Tambookie Grass (*Cymbopogon* spp.), Johnson Grass (*Sorghum halepense*), Elephant Grass (*Pennisetum purpureum*), Norfolk Reeds (*Phragmites communis*), and many others.

Many of the grasses referred to above are capable of yielding pulp of satisfactory properties for use in the paper and board industry, but their application on a commercial scale is in general economically unsound, except under special conditions.

Arundo donax is, however, employed in Italy for the production of high alpha-cellulose pulps. It is noteworthy that the material is plantation-grown.

We have seen that in India sabai grass is used in the paper-making industry, but the available supplies were not large enough to support a major expansion of the pulp industry, for which purpose bamboo was chosen.

The stands of these wild grasses, although very often extensive, are seldom large enough to maintain a mill in operation, since the yield of material per acre is much less than that of forest trees, even taken over a long period of years. Thus, the areas of growth are relatively large and collection from long distances is necessary. Further, the wild stands of growth may be mixed. The question of cultivating a suitable grass on a plantation scale arises, but apart from sabai grass, the extent to which these grasses will stand repeated cropping does not appear to have been ascertained, and the prospects of such enterprise being financially successful in competition with the existing world sources of pulp have so far not looked promising.

The employment of straw, produced as a secondary product in the growing of a food crop, is a different problem.

During the war the esparto-using industry of Great Britain has been converted to the use of straw, and large quantities of bleached paper have been made from this material. To a lesser extent, straw has also been employed for unbleached papers and for board manufacture. Paper-makers in this country have, therefore, gained considerable experience in the technique of handling and processing straw, new processes have been developed and investigated and paper-making engineers have gained knowledge, which, if the need arises, should be of the greatest value in designing new plant specifically for dealing with straw. There are, however, technical limitations to the applications of straw. In strength it cannot equal chemical wood pulps and for printing papers it is inferior to esparto.

To what extent the utilisation of straw by the paper industry of the United Kingdom will continue after the war on any important scale is a controversial question on which it is not proposed to speculate. Obviously, the position will in large measure depend upon the country's post-war agricultural and economic policy.

In the Dominions possibilities for the utilisation of straw also exist, and if conditions are such as to afford prospects of economic success and favourable mill sites are available, the experience gained in the United Kingdom may find successful application.

Miscellaneous Materials.—In the last category of miscellaneous materials mention may be made of nettles.

During the war the possibility of employing nettles for paper-making has received a certain amount of publicity. It is, however, very difficult to believe that such a project could ever be an economic success, and, in fact, this material has not found commercial utilisation. The yield per acre is low, and as distinct from straw, which is an agricultural by-product, the plant would have to be cultivated essentially for paper-making. Furthermore, although nettle stems contain a percentage of long bast fibres, these fibres are associated

with the very short ultimate fibres of the woody portion of the stem, and the difficulty arises of satisfactorily pulping a material composed of two dissimilar fractions. On both technical and economic grounds it is, therefore, not to be anticipated that this material will become of any importance to the paper-making industry.

Another type of material, for which there is a limited and relatively very small demand for specialised purposes, is prepared fibre. The industry already uses manila and hemp fibre in the form of old ropes, and recently Yawa fibre has been under consideration.

Yawa fibre is produced in Nigeria from the flowering stalks of the legume, *Vigna sinensis* var. *textilis*, and is used locally for making fishing nets.

Following initial experiments carried out at the Imperial Institute on this interesting fibre, more elaborate investigations were organised by the Ministry of Supply, and mill trials were also carried out. The general conclusion reached is that Yawa fibre is the best known substitute for true manila hemp. Paper obtained from Yawa fibre can equal manila in tearing and folding strength, and approach it in tensile strength. Moreover, the yield is satisfactory and the fibre runs well on the machine.

Unfortunately, although technically a very desirable material, Yawa has proved too expensive to find application in the paper-making industry.

Attention has often been paid at the Imperial Institute and elsewhere to the value, for paper pulp production, of industrial wastes other than those arising from the textile and cordage industries, the use of which is well established. Such sources have not provided materials of sufficient quality or in economic quantity to be worth commercial development except in the case of spent sugar cane, which has been applied commercially, chiefly for the manufacture of building board.

In a review of this nature it has not been possible to deal at length with the properties of the pulps furnished by the various raw materials, which have been mentioned, or to give in detail the conditions of digestion found to be most suitable. Only the more important new materials have been noticed. References to published information are given below. Acknowledgment is made of these sources for much of the matter from which this review of the subject has been prepared, and of our indebtedness for information to the Senior Trade Commissioner for the Union of South Africa; to Mr. A. L. Poole, Scientific Liaison Officer for the New Zealand Government; and to Mr. G. B. Gresford, of the Australian Scientific Research Liaison Office, London.

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NOTES

Isano Oil.—As a result of the shortage of paint and varnish oils caused by the war, considerable attention has been given during recent years to the possibility of using for this purpose less well-known oils, which hitherto have not been exploited commercially. Among the oils which have been investigated is Isano (*Ongokea klaineana*) oil. In view of the interest that is being shown in isano oil, the following résumé of the information on it, which has already appeared in scientific literature, is now published.

Ongokea klaineana Pierre (=*O. gore* Pierre), belonging to the family Olacaceae, occurs widely in the French and Belgian Congos, where it is known under the native names of "isano," "n'gore" and "ongueko." It is also found in Nigeria and the Gold Coast, but it is nowhere in these two British colonies sufficiently plentiful to afford possibilities of commercial exploitation.

In the event of a demand being created for this oil, supplies will in all probability be made available from the French Congo. It is understood that the kernels do not travel well, so it appears that it may be necessary to prepare the oil in the country of origin.

The tree grows to a height of from 8 to 9 metres and bears small

yellow fruits about 3 cm. in diameter, partly enclosed in a green calyx. The fruit consists of soft pulp surrounding a nut, the latter composed of a cream coloured kernel of softish consistency (59 to 68 per cent.) and a hard shell, 1 to 2 mm. thick (32 to 41 per cent.).

The kernels contain from 58 to 78 per cent. of a reddish yellow, rather viscous oil with an unpleasant odour. This oil has been examined by several observers and the analytical results obtained are given in the following table:

Observers
(With references to Bibliography.)

	Imperial Institute (4).	Steger & Van Loon (16) (4 samples).	Castille (12).	Boekenoogen (8).	Hébert (1, 2).
Specific gravity	0·987 (15/15° C.)	0·9794-0·9838 (20/4° C.)	0·9826 (20/4° C.)	0·973 (20/4° C.)	0·973 (23° C.)
Refractive Index at 20° C.	—	1·5090-1·5101	1·5079	—	—
Viscosity at 20° C., centipoises	—	960-1176	—	730	—
Solidifying Point of Fatty Acids, °C.	Below 8	—	—	—	—
Acid Value	17·7	1·26-21·1	3·8	2·2	4·7
Saponification Value	190	187-194	191·4	189	206·4
Iodine Value . *per cent.*	153	205 (Wijs. 2 hrs.)	143	184 (Wijs. 2 hrs.)	74
Unsaponifiable Matter *per cent.*	2·8	—	3·27	1·1	—
Volatile Fatty Acids, Soluble	1·0	0·37-2·0	—	—	3·35
Volatile Fatty Acids, Insoluble	12·0 (approx.)	0·2*	—	—	—
Acetyl Value	85·5	69-81	67	About 60	—
Diene Number	—	0·37-7·9	—	—	—
Thiocyanogen Number	—	—	64	—	—

* *One sample only.*

These results show that the oil has an unusually high specific gravity and viscosity. It is partially soluble in alcohol and completely so in ether, but it is not soluble in petroleum ether, although it absorbs this solvent to some extent. In these respects it is somewhat similar to castor oil and the acetyl value shows that like castor oil it contains a hydroxylated acid. Isano oil also has a high refractive index, similar to that of tung oil.

The composition of isano oil was first determined by Hébert [1, 2], who stated that it contained glycerides of oleic and linoleic acids and of a highly unsaturated acid, which he called isanic acid. Of the total fatty acids these three were present in the proportions of 15, 75 and 10 per cent. Steger and van Loon [7] have also carried out an investigation on the oil and reported its composition to be: saturated fatty acids, 2·0 per cent.; unsaturated fatty acids, 90·3 per cent.; unsaponifiable matter, 1·1 per cent.; glyceryl radicle, 3·5 per cent.; soluble and insoluble volatile acids, 3·1 per cent. They isolated a fatty acid of the C_{18} series, containing one

double bond and one triple bond. Boekenoogen [8] has questioned the occurrence of such an acid. In later papers Steger and van Loon [14, 15] stated that a main component of isano oil is isanic acid, $C_{18}H_{26}O_2$, containing two acetylenic linkages and one vinyl group, and showed that there were also present glycerides of acids containing one or more unsaturated hydroxy acids. Castille [12] found the solid fatty acids present as glycerides to consist of caproic, caprylic, lauric, palmitic, stearic and arachidic acids. The ether-soluble lead salts of the fatty acids according to this author yielded erythrogenic acid, $C_{18}H_{26}O_2$. The unsaponifiable matter was stated by Castille to contain an alcohol (m.p. 328° C.: insoluble in acetone: acetate, m.p. 192·5° C.), phytosterol, stigmasterol and an unstable oil.

Isano oil would probably be unsuitable for edible purposes on account of its unpleasant odour, viscous nature and dark colour. It yields a dark coloured soap and might be used in making certain kinds of soap. It has been suggested that it might be used as a lubricant. Although it possesses a high iodine value, the untreated oil does not dry even after exposure for a long period. According to Hébert and Heim [3] the oil takes several weeks to dry. This property has been confirmed at the Imperial Institute [4] and also by Steger and van Loon [14], who further stated that the addition of certain metallic naphthenates did not bring about drying. Hébert and Heim [3] in a series of experiments showed that isano oil, after being heated for several hours in contact with air at 120-150° C. without the addition of any driers, dried rapidly when exposed in a thin film to the atmosphere. It has been observed that when the oil is heated alone, it is difficult to control the nature of the resulting product owing to the exothermic reaction that takes place. When litharge or manganese dioxide was added to isano oil and the mixture was heated at 120-150° C. these observers found that the resulting products also dried satisfactorily but that such a long period of heating, especially in the case of manganese dioxide, was not required as when no driers were present. The use of manganese acetate and lead linoleate did not present any advantages over the use of the oil alone.

Hébert and Heim [3] have also recorded the results of varnish-making trials using isano oil. Copal varnishes were prepared containing the oil (*a*) heated alone, (*b*) heated with 10 per cent. of litharge, and (*c*) heated with 5 per cent. of manganese dioxide. These varnishes were hardly dry even after two weeks' exposure at ordinary temperatures. If exposed, however, at 30-35° C. varnishes (*a*) and (*b*) were dry at the end of four or five days and varnish (*c*) within 24 hours. These authors concluded that isano oil was suitable as a substitute for linseed oil in the manufacture of varnishes.

The same authorities [3] have published the results of trials made with isano oil to test its suitability as a raw material for rubber factices. On vulcanisation of the oil, either raw or oxidised,

using sulphur dichloride at low temperatures or sulphur at 150-160° C., the products obtained were always dark coloured, friable and lacking in elasticity and did not possess the properties desired in factices.

Isano oil has been the subject of several patents (Brit. Pat. 509,861 of 12/5/38; Dutch Pat. 46,234 of 15/7/39; U.S. Pat. 2,288,154 of 7/1/41) by Naamlooze Venootschap Industrieele Maatschappij Voorheen Noury and van der Lande of Deventer, Holland [11, 17, 18]. These patentees claim that the oil may be heated to about 280° C. without risk of superheating due to the heat of the reaction if it is mixed with one or more of a number of varnish-making materials. The products are said to have good varnish-making properties. In Brit. Pat. 516,024 of 20/12/39 [13], and U.S. Pat. 2,280,082 of 21/4/42 [19], granted to the same patentees, untreated isano oil is mixed at room temperature with drying or semi-drying vegetable oils or fish oil in the proportion of 1 to 4. Increasing the proportion of isano oil increases the waterproof properties and elasticity of the film but decreases the speed of drying.

Mosinski [9] in French Pat. 818,802 of 2/10/37 heats isano oil with phthalic anhydride and glycerol. The oil polymerises below 240° C. and acquires high drying properties. In a subsequent French patent, 48,914 of 21/9/38, the same patentee [10] treats isano oil with aniline or its derivatives or with sulphur or its compounds to give more suppleness to the film obtained after drying.

The oil-cake from isano kernels contains according to an analysis made at the Imperial Institute [4], 43·4 per cent. of proteins and 7 per cent. of oil. It possessed a faint but somewhat unpleasant garlic-like taste and was found to be free from alkaloids and cyanogenetic glucosides. The cake has a high nutritive value, but feeding trials are necessary to ascertain whether it can be recommended as a feeding-stuff for animals.

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The Properties and Practical Application of Wattle Tannin. *J. Leath. Indust. Res. Inst., S. Afr.*, 1944, **1**, May, 1-219. Divided in three parts: Part I deals with physical and other properties of wattle tannin, Part II discusses the organic structure of the tannin, and Part III gives accounts of its practical application.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 28

(July to September 1944)

Compiled by Miss R. M. Johnson

With the collaboration of the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Comparison of Fixed Coppers and Bordeaux Mixture in the Control of Insects and Diseases on muck-grown Irish Cobbler Potatoes. By J. P. Sleesman and J. D. Wilson. *Bi-Mthly. Bull. Ohio Agric. Exp. Sta.*, 1943. (*R.A.E.*, 1944, **32**, A, Pt. 4, 112-113.) Spraying with fixed nicotine resulted in low degree of leaf-hopper control: dusts of copper oxychloride-sulphate with derris or pyrethrum were slightly inferior to Bordeaux mixture alone against flea-beetles.

The Cabbage Looper as a Pest of Lettuce in the Southwest. By K. B. McKinney. *Tech. Bull. No.* 846, *U.S. Dep. Agric.*, 1944. When insecticide applications are required within 4 or 5 weeks prior to harvest or so near harvest time that residues will remain on the marketable product the loopers can be controlled by dusting with a dust containing 0.5-1.0 per cent. rotenone or a mixture of pyrethrum and talc.

Insect Powder for Dogs. *Chem. and Drugg.*, 1944, **142**, No. 3362, 78. Contains derris or pyrethrum.

Manufacture of (A) Rotenone (B) Pyrethrum Extracts. B.P. 559,647 and 559,735. *Brit. Chem. Physiol. Absts.*, 1944, B III, June, 109.

Controlling Severe Codling Moth Infestations. By W. S. Hough. *Virginia St. Hort. Soc. Proc.* 1943, **48**, (*Amer. Chem. Absts.*, 1944, **38**, No. 9, 2158-2159.) Properly-timed sprays of nicotine sulphate were effective against adult stages of the moth: a thiocyanate-pyrethrum spray also gave promising results.

Sprays for the Control of Ticks about Houses or Camps. By C. N. Smith and H. K. Gouck. *J. Econ. Ent.*, 1944, **37**, No. 1, pp. 85-87. Nicotine spray or pyrethrum spray gave satisfactory results.

Toxicity of DDT to *Blattella germanica*, as Compared with Sodium Fluoride, Derris and Pyrethrum. By J. M. Ginsburg. *J. Econ. Ent.*, 1944, **37**, No. 1, p. 122.

Insecticide Testing. A Review of Test Procedure for Evaluating Household Insecticides for use in the Control of Flies, Clothes Moths, Roaches and Rodents. By H. J. Cox. *Soap*, 1944, **20**, No. 6, 114-117, 149; No. 7, 123-125, 129.

Effects of Paralytic Insecticides on Heart Pulsations and Circulation of the Blood of the American Cockroach. By B. F. Coon. *Ohio St. Univ., Abst. Doctoral Diss.*, 1942, No. 40, 29-33. (*Exp. Sta. Rec.*, 1944, **90**, No. 5, 658.) Pyrethrum and nicotine were among the products used in the experiments.

Ground Flea Damage and Control. By J. Noll. *Kranke Pflanze*, 1942, **19**, 67-70. (*Amer. Chem. Absts.*, 1944, **38**, No. 11, 2783.) Tobacco dust, nicotine, derris and pyrethrum produce the best control.

Recent Tests of Materials for Potato Spraying in Pennsylvania. By H. W. Thurston. *Amer. Pot. J.*, 1944, **21**, 55-59. (*Amer. Chem. Absts.*, 1944, **38**, No. 12, p. 3078). Addition of contact insecticides such as derris and nicotine sulphate to copper sprays reduced the insect populations, especially aphids, but often had a depressing effect on the potato yields.

Testing Insecticides on the Argasid Tick, *Ornithodorus moubata* Murray. *Bull. Ento. Res.*, 1944, **35**, Pt. 2, 95-99. A number of materials were tested, including rotenone, nicotine and pyrethrum. Of all the sprays and dusts used those containing pyrethrum were outstanding in their toxicity.

Further Tests of Dusts in Control of Mirids and Pentatomids. By J. T. Medler and E. J. O'Neal. *J. Econ. Ent.*, 1944, **37**, No. 2, 316-318. Pyrethrum-sulphur mixtures and rotenone-sulphur mixtures gave promising results.

Tests of Repellents against Chiggers. By A. H. Madden, A. R. Lindquist and E. F. Knipling. *J. Econ. Ent.*, 1944, **37**, No. 2, 283-286. Pyrethrum and rotenone dusts were tested but dimethyl phthalate considered to be the most satisfactory repellent.

The Effect of Some Insecticides in Aerosol Form against the Cyclamen Mite on Snapdragon. By L. D. Goodhue and F. F. Smith. *J. Econ. Ent.*, 1944, **37**, No. 2, 214-218. Pyrethrum, rotenone, derris and nicotine were among the thirty-two different insecticides tested, but none of these were found so promising as lorol thiocyanate.

" Incompatability " of Insecticides. By R. C. Roark. *J. Econ. Ent.*, 1944, **37**, No. 2, 302.

Tomato Pinworm Control in the Greenhouse. By L. D. Anderson and H. G. Walker. *J. Econ. Ent.*, 1944, **37**, No. 2, 264-268. Pyrethrum and rotenone effective.

Entomological Progress. Number 3. *Bull. No.* 350, *Louisiana Agric. Exp. Sta.*, 1942. (*R.A.E.*, 1944, **32**, A, Pt. 7, 233-237.) Nicotine dusts gave significant reductions in populations of nymphs and adults of *Psallus seriatus* on cotton ; in tests to discover a substitute for arsenical insecticides against cabbage caterpillars it was found that dusts containing fixed nicotine were of little or no value, and applications of a dust of derris and talc were not very satisfactory ; in work on the control of the red spider on strawberry rotenone dip killed the mites but not the eggs and nicotine sulphate did not give complete mortality of the active stages.

Blueberry Insects and Their Control. *Publ. No.* 754, *Dep. Agric. Canada*, 1943. Derris dust controls *Rhagoletis pomonella* but too expensive except for cultivated blueberries : a single test of pyrethrum dust against the currant fruit weevil gave considerable success ; rotenone dust gave control of *Haltica torquata* and *Galerucella vaccinii*.

Biology and Control of the Turnip Aphid. By P. K. Harrison and N. Allen. *Bull. No.* 365, *Louisiana Agric. Exp. Sta.*, 1943. (*Amer. Chem. Absts.*, 1944, **38**, No. 15, 4085.) Pine-tar soap spray gave 90 per cent. control in presence of high humidity and low temperature, but nicotine sulphate had to be added to obtain satisfactory kill in cases of low humidity and high temperature : most promising insecticides (1) nicotine, (2) derris root diluted with tobacco dust and sulphur.

Further Refinement of a Technique for Testing Contact Insecticides. By W. S. McLeod. *Canad. J. Res.*, 1944, **22**, Sec. D, No. 4, 87-104.

Development of Non-residue Spray Program for Apples and Pears. By

S. W. Harriman. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p. 28. Nicotine and rotenone when used with certain refined oils have proved as toxic as lead arsenate to most pests, a conspicuous exception being the apple maggot.

Development of a General Spray-Dust Program for Cabbage under Western New York Conditions. By H. Glasgow and G. E. R. Hervey. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p. 27. Sprays of dusts in which arsenicals are mixed with such contact insecticides as nicotine and rotenone are effective against most of the major cabbage pests.

War Substitute Insecticides for European Corn Borer Control. By L. A. Carruth. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p. 27. Nicotine dust diluted with walnut shell flour gave good control, and is a satisfactory substitute for rotenone and dual-fixed nicotine dust.

Biology and Control of Insects Affecting Cannery and Market Peas. By H. Glasgow. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p. 26. In a study of various insecticides and the development of machinery and methods of application nicotine and rotenone were found to give the best control.

Control of the Current Stem Girdler and Allied Insects, including the Imported Currant Borer. By F. G. Mundinger. *Ann. Rep. New York State Exp. Sta.*, 1943, p. 30. Tests of over one hundred different mixtures have indicated that rotenone sprays and dusts are the most effective insecticides. Pyrethrum dusts gave promise also.

Biology and Control of the Grape Berry Moth. By F. Z. Hartzell and E. F. Taschenberg. *Ann. Rep. New York State Exp. Sta.*, 1943, p. 30. A satisfactory spray programme consists of one application of calcium arsenate and a nicotine treatment for the first brood and two applications of either nicotine or rotenone spray for the second brood.

Biology and Control of the Codling Moth and Certain Other Fruit Insects in Eastern New York. By P. J. Chapman, R. W. Dean and J. L. Brann. *Ann. Rep. New York State Exp. Sta.*, 1943, p. 28-29. Nicotine sprays and castor bean extract among the treatments which gave satisfactory control of the codling moth: cube and nicotine successful against apple maggot: cube and aliphatic thiocyanate dust superior to a straight cube dust against cherry fruit flies.

A Monographic Study of Bean Diseases and Methods for Their Control. By L. L. Harter and W. J. Zaumeyer. *Tech. Bull. No.* 868, *U.S. Dep. Agric.*, 1944. In the section on diseases due to insects reference is made to the partial control of leafhoppers given by Bordeaux mixture with added nicotine sulphate and complete control obtained by dusting with pyrethrum-sulphur mixture.

Blueberry Growing. By G. M. Darrow, R. B. Wilcox and C. S. Beckwith. *Frms.' Bull. No.* 1951, *U.S. Dep. Agric.*, 1944. Contains references to the use of (a) derris for dealing with the blueberry maggot, (b) pyrethrum dust for the control of *Mineoli vaccinii* and *Anthonomus musculus*.

Über Konstitution und toxische Wirkung von natürlichen und neuen synthetischen insektentötenden Stoffen. By von P. Lauger, H. Martin und P. Müller. *Helv. Chim. Acta*, 1944, p. 892.

Are Household Insecticides Luxuries? By O. F. Hedenberg. *Soap*, 1944, **20**, No. 8, 96.

A Method for Evaluating Treatments for Grape Leafhopper and for analysing the Heterogeneity of the Infestation. By F. Z. Hartzell and J. L. Horsfall. *J. Econ. Ent.*, 1944, **37**, No. 2, p. 219.

The Use of Explosives for the Application of Insecticide Dusts. By R. D. Glasgow and R. Blair. *J. Econ. Ent.*, 1944, **37**, No. 2, p. 230.

Size Specifications for Fine Powder. By E. L. Gooden. *J. Econ. Ent.*, 1944, **37**, No. 2, p. 204.

OPA Permits Advances in Rotenone and Pyrethrum Prices. *Soap*, 1944, **20**, No. 7, 131, No. 8, 115.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Insecticidal Possibilities of *Duboisia hopwoodii.* By C. V. Bowen. *J. Econ. Ent.*, 1944, **37,** No. 2, 293. Nornicotine present and plant seems worth exploiting.

Control of Black Aphis on Sugar Beet. *Public Ledger* 1944, *No.* 33, 512, 6. Refers to arrangements made by the Ministry of Agriculture whereby machines will be available for (a) dusting of field with nicotine and (b) gassing with vaporised nicotine.

Determination of Nicotine and Nornicotine in Tobaccos. By C. V. Bower and W. F. Barthel. *Industr. Engng. Chem., Anal. Ed.*, 1943, **15,** No. 12, 740-741.

Nicotine for Aphids. By B. Smit. *Frmg. S. Afr.*, 1944, **19,** No. 220, 425-428.

Fabricação de produtos de nicotina. *Rev. Quim. Industr. Brazil,* 1944, **13,** No. 144, 28-30. Reviews the principal processes for the manufacture of nicotine.

Poisoning of Cattle Through the Use of Nicotine and Lime Dressing for Warbles. By R. E. McGrath and D. Campbell. *Vet. Rec.*, 1944, **56,** 64-65. (*Vet. Bull.*, 1944, **14,** No. 7, 249.)

Nicotine Fumigation Injury to Biloxi Soybean. By A. P. Withrew and J. P. Biebel. *Phytopathology*, 1944, **34,** No. 2, 256-257. (*Exp. Sta. Rec.*, 1944, **90,** No. 6, 804.)

Nicotine Sprays in Viniculture. By E. Stellwaag. *Tabak*, 1940, 1, 149-151. (*Amer. Chem. Absts.*, 1944, **38,** No. 11, 2783.) Nicotine-containing preparations valuable as supplement to arsenical preparations and can be used to combat the most important pests.

The Larch Grub Moth (*Coleophora laricella* Hb.). By W. Jung. *Z. Angew. Entomol.*, 1942, **29,** 475-517. (*Amer. Chem. Absts.*, 1944, **38,** No. 10, 2783.) Nicotine sprays effective in controlling the pest.

Control of Shade-tree Insects. By W. P. Flint and M. D. Farrar. *Natl. Shade Tree Conf.*, 1942, **18,** 139-148. (*Amer. Chem. Absts.*, 1944, **38,** No. 10, 2438.) Fixed nicotine and summer oil spray satisfactory for dealing with leaf-eating insects.

1942 Leaf-Roller Control. By P. Stark. *Trans. Illinois St. Hort. Soc.*, 1942, **76,** 241-242. (*Amer. Chem. Absts.*, 1944, **38,** No. 10, 2439.) A spray which included nicotine sulphate killed most of the leaf rollers that were still active on apple trees during the 3rd cover spray period.

Described Nicotine Research. *Soap,* 1944, **20,** No. 6, 121. Outlines recent work done on the use of nicotine as an insecticide at the Eastern Regional Research Laboratory, U.S. Department of Agriculture.

A Note on the Alkaloid in *Eclipta alba* (Hassk.). By S. N. Pal and M. Narasimham. *J. Indian Chem. Soc.*, 1943, **20,** 181. *Pharm. Absts.*, 1944, **10,** No. 5, 134. Publd. in *J. Amer. Pharm. Assoc., Sci. Ed.*, 1944, **33,** No. 5. The alkaloid has been identified as nicotine.

The Apple Leafhopper (*Typhlocyba froggatti* Baker). By C. F. H. Jenkins. *J. Dep. Agric. W. Aust.*, 1943, **20,** No. 3, 190-195. (*R.A.E.*, 1944, **32,** A, Pt. 7, 227-228.) Satisfactory control obtained with a nicotine spray.

Red-legged Earth Mites. *Agric. Gaz. N.S.W.*, 1944, **55,** Pt. 5, 203-204. Nicotine spray or nicotine dust recommended for dealing with the pests attacking vegetables and flowers.

A Comparison of Dust and Spray Programs for Codling Moth Control. By S. W. Harman. *J. Econ. Ent.*, 1944, **37,** No. 2, 208-211. Nicotine among the products experimented with.

Effects of Nicotine Dust on the Melon Aphis and Its Natural Enemies. By R. R. Walton and F. E. Whitehead. *J. Econ. Ent.*, 1944, **37,** No. 2, 310.

Observations on Two Raspberry Troubles. By G. F. Wilson and D. E.

Green. *J. Roy. Hort. Soc.*, 1944, **32**, A, Pt. 8, 258-259. (*R.A.E.*, 1944, **32**, A, Pt. 8, 258-259.) Nicotine spray was effective in dealing with young larvae of *Thomasiniana theobaldi* in June, but later applications ineffective as the spray did not penetrate the hard rind of the older canes.

Chrysanthemum Midge (*Diarthronomyia chrysanthemi*). *Adv. Leafl. No.* 286, *Minist. Agric. Lond.*, 1944. A nicotine spray suitable for controlling the pest.

Leafhoppers—Can They Get the Cream of the Crop ? By N. F. Childers. *Amer. Fruit Grower*, 1944, **64**, No. 2, 28-29. (*Exp. Sta. Rec.*, 1944, **91**, No. 2, 179.) Nicotine spray or dust recommended against these pests.

Codling Moth Situation in 1943 in the Vicinity of Roanoke. By J. A. Cox. *Virginia Fruit*, 1944, **32**, No. 1, 53-57. (*Exp. Sta. Rec.*, 1944, **91**, No. 1, 56.) Nicotine sulphate with lead arsenate used.

Other Alkaloid-containing Materials

Moth Killer. German Pat. No. 731,339. *Soap*, 1944, **20**, No. 5, 105. Formaldehyde, picrotoxin and veratrine are added to an alcoholic solution of salicylic acid and boric acid to produce a moth-killing agent.

Toxicity of Anabasine to the Citrus Thrips. By E. A. McGregor. *J. Econ. Ent.*, 1944, **37**, No. 1, 78-80.

Anabasine and Gesarol vs. Citrus Thrips. By E. A. McGregor. *Calif. Citrog.*, 1943, **29**, No. 2, 30. (*Exp. Sta. Rec.*, 1944, **90**, No. 6, 810.) Anabasine showed high toxicity.

Histological Effects of Piperine on the Central Nervous System of the Housefly. By A. Hartzell and M. Strong. *Contrib. Boyce Thompson Inst.*, 1944, **13**, No. 5, 253-257. (*Exp. Sta. Rec.*, 1944, **13**, No. 5, 253-257.)

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Rotenone and Its Use in Insecticides. By G. A. Hepburn. *Frmg. S. Afr.*, 1944, **19**, No. 219, 383-384, 394.

The Qualitative Examination of Insecticidal Properties. Progress Report 1943. By H. Martin, A. Stringer and R. L. Wain. *Ann. Rep. Long Ashton Agric. and Hort. Res. Sta.*, 1943. Rotenone and allied insecticides among the products examined.

Insecticidal Spray Compositions Suitable for Use on Vegetation. U.S. Pat. No. 2,335,862. Substantially a saturated solution of rotenone in dibutyl urea. (*Amer. Chem. Absts.*, 1944, **38**, No. 12, 3082.)

Field Experiments with Oil-toxicant Sprays for Red Scale. By W. Ebeling and J. P. La Due. *Calif. Citrog.*, 1943, **29**, No. 2, 32, 40, 52-53. (*Exp. Sta. Rec.*, 1944, **90**, No. 6, 808.) Discusses the use of rotenone sprays.

Sprays and Dusts for Cherry Fruit Fly Control. By S. C. Jones. *Oregon St. Hort. Soc. Ann. Rep.*, 1943, **35**, 65-67. (*Amer. Chem. Absts.*, 1944, **38**, No. 10, 2439.) Rotenone and molasses spray effective.

Rotenone Powder. IV. Light and Sunshine. By J. Feytaud and P. de Lapparent. *Compt. Rend. Acad. Agric. France*, 1941, **27**, 663-668. (*Amer. Chem. Absts.*, 1944, **38**, No. 9, 2159.)

Control of the Mexican Bean Beetle in Irrigated Districts in the West. By R. L. Wallis. *Circ. No.* 675, *U.S. Dep. Agric.* In field experiments derris or cube sprays containing 0.02 per cent. rotenone or derris containing 0.015 per cent. of rotenone gave satisfactory control of *Epilachna varivestis* and good financial gains : use of derris and cube dusts for controlling the pests on garden or canning beans also discussed.

Fluorine Compounds as Alternates for Rotenone-bearing Dusts. By N. Turner. *J. Econ. Ent.*, 1944, **37**, No. 2, 242-245.

Toxicity of Rotenone to Animals. A Review and Comparison of Responses shown by Various Species of Insects, Fishes, Birds, Mammals, etc. By L. K. Cutkomp. *Soap*, 1943, **19**, No. 10, 107-116.

Rotenone Dust and Sprays. Loss of Rotenone and Deguelin from Alkaline and Acid Rotenone Dust Mixtures and Sprays. By R. H. Robinson and M. B. Hatch. *Soap*, 1944, **20**, No. 4, 125-131.

Control of Tomato Flea Beetle and Its Relation to Leaf Blight. By G. R. Hervey. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p. 26-27. Rotenone dust and talc dust without other insecticides or fungicides were somewhat less effective than calcium arsenate dust.

The Biology and Control of the Striped Cucumber Beetle. By G. E. Gould. *Bull. No.* 490, *Indiana Exp. Sta.*, 1944. (*Exp. Sta. Rec.*, 1944, **91**, No. 2, 178.) Rotenone dust mixtures resulted in satisfactory beetle control, but had little residual effect.

Spray and Dust Controls for Lima Bean Pests. By H. C. Huckett. *Food Packer*, 1944, **25**, No. 1, 44-45. (*Exp. Sta. Rec.*, 1944, **91**, No. 1, 55-56.) Rotenone dusts recommended.

Up to Now with Citrus Insecticides. By A. M. Boyce. *Calif. Citrog.*, 1944, **29**, No. 5, 117. (*Exp. Sta. Rec.*, 1944, **91**, No. 2, 180.) Rotenone referred to.

Derris

Brazil Derris Production. *Public Ledger*, 1944, No. 33,533, 1.

Sources of Variations in the Effectiveness of Derris Dusts. By J. M. Hutzel and N. F. Howard. *J. Econ. Ent.*, 1944, **37**, No. 1, 65-69.

The Potato Moth. Experiments on its Control. By N. C. Lloyd. *Agric. Gaz. N.S.W.*, 1944, **55**, Pt. 5, 193-196. An experiment was carried out using derris dust for control of the moth in stored tubers; satisfactory result obtained from a seed-saving point of view.

A Low Rotenone Content *Derris malaccensis* Dust Effective Against Certain Vegetable Pests. By B. B. Pepper and R. S. Filmer. *J. Econ. Ent.*, 1944, **37**, No. 2, 248-252.

Ground Derris Root as a Mosquito Larvicide. By G. Pasfield and A. R. Woodhill. *Proc. Linn. Soc. N.S.W.*, 1942, **67**, Pt. 5-6, 343-348. (*R.A.E.*, 1944, **32**, B, Pt. 8, 147.)

Local Derris Root for Scabies. By A. W. Williams. *E. Afr. Med. J.*, 1943, **20**, No. 12, 396-398. (*R.A.E.*, 1944, **32**, B, Pt. 8, 160.)

El barbasco (derris). By A. F. Sievers. *Rev. Inst. Defensa Cafe, Costa Rica*, 1943, **13**, No. 107-108, 621-632. (*Exp. Sta. Rec.*, 1944, **91**, No. 1, 54.) General discussion of derris species and varieties, cultivation methods, marketing, etc.

The Flowering of *Derris elliptica*. *E. Afr. Agric. J.*, 1944, **10**, No. 1, 6. Growers warned not to grow derris from seed.

Derris Crop. Sao Paulo, Brazil. *Foreign Comm. Wkly.*, 1944, **15**, No. 7, 22.

DDT as a Substitute for Derris against the European Corn Borer. By D. D. Questel. *J. Econ. Ent.*, 1944, **37**, No. 1, p. 149.

Lonchocarpus

"Barbasco." A Growing Industry in the Amazon Valley. By F. J. Pound. *Proc. Agric. Soc. Trin. Tob.*, 1943, **43**, Pt. 4, 269-275. Account of the cultivation of *Lonchocarpus nicou*.

Lagunas-Barbasco Capital of the World." By E. C. Higbee. *Agric. in Americas*, 1944, **4**, No. 5, 83-86, 95, 96. An account of the cultivation and production of Lonchocarpus in Peru.

Others

Sobre el Valor Insecticida de las Raices de dos Tephrosias Argentinas. By N. Giovambattista. *Rev. Fac. Cienc. Quim., La Plata*, 1942, **17**, 83-91.

Of the species of Tephrosia in the Argentine one contains no rotenone (*T. adunca*) and the other (*T. cinerea*) only 0.1 per cent. in the root.

Common Red Spider on Lima Beans and its Control. By H. C. Huckett. *Ann. Rep. New York State Agric. Exp. Sta.*, 1943, p.28. Cube and cube with lethane were not effective in control.

PYRETHRIN-CONTAINING MATERIALS

Annual Report of the Department of Agriculture, Mauritius, for 1942. Petroleum-pyrethrum fly spray made by the Division of Entomology and marketed locally under the name Pyex.

Activation of Pyrethrins in Sesame Oil. By E. A. Parkin and A. A. Green. *Nature*, 1944, **154**, No. 3896, 16-17. A reply to a letter by Daird and Bracey on the effect of sesame oil as an activator of pyrethrins.

Flowers that Fight Malaria. By R. E. Culbertson. *Agric. in Americas*, 1944, **4**, No. 4, 66-68. An account of pyrethrum production, particularly in Peru and Ecuador.

Synthetic Roach Powders. Use of Organic Thiocyanates in Powdered Form for Roach Control in Place of Pyrethrum. *Soap*, 1944, **20**, No. 5, 102-105.

Brazilian Pyrethrum. *Soap*, 1944, **20**, No. 6, 133. Brief note to the effect that pyrethrum flowers from Brazil are too low in pyrethrins for use in Army aerosol insecticides.

Pratique de la culture du caféier arabica par les indigènes de Ruanda Nord. By L. Michel. *Bull. Agric. Congo Belge, Léopoldville*, 1943, **34**, No. 1-4, 109-121. Describes method of employing pyrethrum dusts against pests of coffee in this district of the Belgian Congo.

Control of *Diabrotica*, or Western Spotted Cucumber Beetle, in Deciduous Fruit Orchards. By A. E. Michelbacher, G. F. MacLeod and R. F. Smith. *Bull. No.* 681, *Calif. Exp. Sta.*, 1943. (*Exp. Sta. Rec.*, 1944, **90**, No. 5, 662.) Dusts containing pyrethrins gave satisfactory control under certain conditions.

Introduction to the Study of Tsetse-Fly Repellents in the Field of Veterinary Science. By H. E. Hornby and M. H. French. *Roy. Soc. Trop. Med. and Hyg. Trans.*, 1943, **37**, No. 1, 41-54. (*Exp. Sta. Rec.*, 1944, **90**, No. 6, 814.) A technique was developed for comparing the repellant action of any substance with that of pyrethrum, which was the only one among about 150 materials showing promise of practical efficacy in the veterinary field.

Aerosols vs. Oil Spray Insecticides. A Study of Comparative Efficiency. By J. H. Fales and L. D. Goodhue. *Soap*, 1944, **20**, No. 7, 107-108. Pyrethrum extract used in the experiment described.

Pyrethrins for Aerosols. The Preparation of 98 per cent. Pure Pyrethrins for Use in Freon Aerosol Bombs. By W. F. Barthel, H. L. Haller and F. B. La Forge. *Soap*, 1944, **20**, No. 7, 121, 135.

Liquefied Gas Aerosols—Postwar. By W. W. Rhodes. *Soap*, 1944, **20**, No. 7, 108-111.

Aerosol Bombs vs. Spray Insecticides. By R. O. Cowin. *Soap*, 1944, **20**, No. 7, 111-113.

Another View of Aerosol Efficiency. By N. J. Gothard. *Soap*, 1944, **20**, No. 7, 113-115.

The Use of Freon in Insecticides. By L. D. Goodhue. *Refrig. Engr.*, 1944, **47**, No. 1, 26-27. (*Exp. Sta. Rec.*, 1944, **90**, No. 5, 800.) A satisfactory aerosol is produced from a solution of pyrethrum extract and sesame oil in liquid dichlorodifluoromethane (Freon-12).

Army Aerosol Program. *Soap*, 1944, **20**, No. 5, 110-113. Refers to tests which were carried out with DDT to replace pyrethrum.

The Mechanism of Action of a Contact Insecticide. By D. N. Roy and S. M. Ghosh. *Bull. Ento. Res.*, 1944, **35**, Pt. 2, 161-170. Pyrethrum one of the materials studied.

Cockroach Control. By H. D. Tate and E. C. Klostermeyer. *Circ. No.*

72, *Nebraska Exp. Sta.*, 1943. Application of dusts of sodium fluoride, pyrethrum or borax recommended.

Army Worms or Swarming Caterpillars (*Laphygma exempta* Wlk.). By C. Smee. *Nyasald. Agric. Quart. J.*, 1943, **3**, No. 4, 1-16. (*R.A.E.*, 1944, **32**, A, Pt. 6, 222-224.) A thorough application of pyrethrum dust was found effective and rapid in action against almost fully-grown larvae.

"Lethane 384 Special" for Control of the Brown Dog Tick. By G. H. Plumb. *J. Econ. Ent.*, 1944, **37**, No. 2, 292-293. This dust contained a proprietary pyrethrum composition.

The House Fly and Its Control. By P. J. Deoras and Arjan Singh Jandu. *Indian Frmg.*, 1943, **4**, No. 11, 565-568. Refers to the use of neem leaf smoke as a repellant, the value of anti-fly candles containing pyrethrum, and pyrethrum sprays.

Pyrethrum. Promising Developments in Areas of Peru and Ecuador. *Public Ledger*, 1944, No. 33,559, 4.

Ceylon Pyrethrum Development. *Public Ledger*, 1944, No. 33,555, 1.

Synthetic Organic Compounds Patented for Use as Substitutes for Pyrethrum. By C. V. Bowen and L. E. Smith. *Publ. U.S. Dep. Agric. Bur. Entomol.*, 1944.

A Study of the Control of the Yellow-dwarf Disease of Potatoes. By E. D. Hansing. *Bull. No.* 792, *Cornell Agric. Exp. Sta.*, 1943. (*Amer. Chem. Absts.*, 1944, **38**, No. 15, 4084.) Pyrethrum among the materials which reduced the spread of the disease.

Pyrethrum. *Soap*, 1944, **20**, No. 4, 121-123. An investigation of the pyrethrum side of the post-war insecticide market.

Malaria Control by Spray-killing Adult Mosquitoes: Fourth Season's Results. By P. F. Russell, F. W. Knipe and N. R. Sitapathy. *J. Malar. Inst. India*, 1943, **5**, No. 1, 59-76. (*R.A.E.*, 1944, **32**, B, Pt. 8,150.) Spraying of houses, animal sheds and outbuildings with pyrethrum extract to kill *Anophelines* proved effective and confirmed experimental work done in previous seasons.

Report of the Acting Director of Agriculture, Ceylon, for 1942. (*R.A.E.*, 1944, **32**, A, Pt. 7, 248.) Extracts from pyrethrum grown in Ceylon were fairly toxic to aphids.

Note on the Control of the Root Knot Eelworm, *Heterodera marioni*. By R. M. Nattrass. *E. Afr. Agric. J.*, 1944, **10**, No. 1, 43. Found attacking pyrethrum crops in Kenya.

Pyrethrum Cultivation in Madras. *Indian For.*, 1944, **70**, No. 8, 265. Mentions a grant by the Madras Government for experimental pyrethrum cultivation in the Nilgiris and the Palnis.

The Pyrethrins and the Role of Pyrethrum in Anti-pest Measures. Pt. I. By T. F. West. *Chem. and Industr.*, 1944, No. 33, 290.

Mortality of Bedbugs on Rabbits Given Oral Dosages of DDT and Pyrethrum. By A. W. Lindquist, E. F. Knipling, H. A. Jones and A. H. Madden. *J. Econ. Ent.*, 1944, **37**, No. 1, 128.

Constituents of Pyrethrum Flowers. XVI. Heterogeneous Nature of Pyrethrolone. By F. B. LaForge and W. F. Barthel. *J. Org. Chem.*, 1944, **9**, No. 3, 242-249. It is shown that pyrethrolone is a mixture of components differing with respect to the nature of the side chain.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Anethole and Pimenta Leaf Oil as Attractants for the Japanese Beetle. By W. E. Fleming and R. D. Chisholm. *J. Econ. Ent.*, 1944, **37**, No. 1, 116.

Mineral Oils as Diluents of the Geraniol-Eugenol Japanese Beetle Bait. By M. H. Huma, G. S. Langford and E. N. Cory. *J. Econ. Ent.*, 1944, **37**, No. 2, 295-297.

New Products in Peru for Use Against Cotton Pests. *Public Ledger*,

1944, No. 33,576, 1. Peruvian factory producing a new insecticide powder intended for use against pests of cotton: composed of Chili pepper, sabadilla, arsenic and quick lime; known as "Babbini."

Further Tests on Plant Products for Insecticidal Properties. By A. Hartzell. *Contrib. Boyce Thompson Inst.*, 1944, **13**, No. 5, 243-252. (*Exp. Sta. Rec.*, 1944, **91**, No. 1, 54.) Out of 125 plants tested acetone extract of eleven species showed promise when tested against the larvae of the southern house mosquito: these were cubeb berries, black pepper, *Koelreuteria paniculata* seeds and leaves, elder flowers, jalap root, *Papaver* flowers and stems, and seeds of two varieties of squashes, anise, cucumber and melon.

A New Constituent Isolated from Southern Prickly Ash Bark. By F. B. LaForge and W. F. Barthel. *J. Org. Chem.*, 1944, **9**, No. 3, 250-253. The isolation of N-(2-*p*-anisylethyl)-N-methylcinnamide is described.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

TIMBERS OF THE NEW WORLD. By Samuel J. Record and Robert W. Hess. Pp. xv + 640, 10¼ × 7. (New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press, 1943.) Price 66*s*. 6*d*.

For twenty years Professor Record's *Timbers of Tropical America* has been a work of reference indispensable to scientists and timber men concerned with the woods occurring in the American tropics and, in particular, those found in the Amazon basin, the world's last great storehouse of tropical timbers not yet in important commercial exploitation. The knowledge that an expanded and virtually rewritten edition of this work was in preparation aroused much interest, and we now have available the volume under notice which at once takes its place as the standard work on the most important timber-bearing region of the world.

The new title of the book indicates the essential difference between the two volumes. Professor Record and Professor Hess in *Timbers of the New World* have accomplished the great task of describing the timbers and other products of the trees and larger woody shrubs of the whole of the Western Hemisphere apart from the Pacific Islands. This means that in addition to the timbers of tropical America formerly dealt with, descriptions of the wealth of timber species of the United States and Canada, softwoods and hardwoods, which play so large a part in the world's timber trade and industries, form a component of the new work. The importance of Latin American countries in the picture, however, is shown by the fact that they contain about 90 per cent. of the woody species of the region covered by the authors.

The arrangement of the subject matter of the book is primarily botanical. The trees are considered in the two great natural groups, viz., the Gymnosperms (conifers) supplying the softwoods, and the Angiosperms or broad-leaved trees which are the source of the

hardwoods. The sequence of the families and genera within these groups is alphabetical in both cases, which in the circumstances is the most convenient arrangement. An account is given of the characters and economic importance of each family, special reference being made to the technical features of the timbers occurring within the group. Within each family the genera are taken successively and the species concerned, arranged in order of their scientific names, receive detailed treatment completed by a list of the common trade and vernacular names of the timber. It follows that in seeking information on a wood whose position in the botanical classification is not known to the inquirer reference must first be made to the exhaustive general index in which botanical names are indicated in italics.

The information supplied is of great practical value. It includes descriptions of the trees and their geographical distribution, deals with the practical characteristics of the timbers and supplies the basic information for their identification. This latter difficult subject is aided by a lucid " Explanation of the Wood Descriptions," which discusses the technical terms used in the text descriptions; much of the technical histological information, however, is necessarily intended for the wood anatomist. A further useful feature is a list of plant families classified according to special properties and uses of their barks, leaves and timbers. Much valuable information can be extracted by a study of this list, which virtually serves as a " subject index " to the contents of the volume and, incidentally, furnishes suggestions in answer to the recurrent inquiries for substitutes for or alternatives to established woods.

The scope of the volume is indicated by the fact that the woods of over 1,100 genera and 115 natural families are described. Moreover, the work is not solely concerned with timbers as such, since it also indicates those species of value as present or potential sources of other plant products, e.g. rubber, resins, oils, tannins, dyestuffs, drugs and fibres. It contains more than twice the amount of subject matter in the original work, and economy of printed space has been effected by the use of double-column pages. Reference must be made to the many full-page photographs of typical or remarkable tree species, the series of maps illustrating the range of selected trees, and the excellent photo-micrographs of wood structure. As would be expected there is a copious bibliography.

The preface concludes with a quotation from the *Timbers of Tropical America* which in 1924 disclaimed for that work anything more than " a general reconnaissance " of the subject on account of the vast extent of the field covered and the fragmentary nature of the information then available. The authors would appreciate the present volume at a similar modest estimate in view of the knowledge yet to be gained. This may be true, but for the time being the book stands alone as containing the most complete account of a subject of high and increasing importance.

S. E. C.

British Timbers. Their Properties, Uses and Identification. By E. H. B. Boulton, M.C., M.A., Dip. For. (Cantab.) and B. Alwyn Jay, M.A. For. (Cantab.), F.L.S. Pp. 112, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: Adam and Charles Black, 1944.) Price 12*s.* 6*d.*

The former neglect of forestry in this country as a source of commercial timber had a parallel in the comparative absence of literature dealing with the British aspects of forestry and home-grown timbers as such. Two wars have emphasised the importance of home supplies of wood for national purposes, and have resulted in serious, if restricted, attention being given not only to the sylviculture of timber-yielding species in this country, but also to the study of the timbers produced. Some of these timbers have long been famous for their technical value while others in stress of circumstances have been proved to be well suited for many purposes for which previously they had been little, if at all, employed. In the select practical literature on the subject which concurrently has come into being the book under notice, written by authors well qualified in forestry and having much experience in the technical direction of the Timber Development Association, should be of special value as a practical handbook for the owners of plantations and timber merchants and users alike. The book is designed to give an account of home-grown timbers and their uses and also the salient features of the sylviculture of the trees. The species are described in alphabetical order in the groups of Hardwoods and Softwoods, separate chapters being devoted to the principal timbers and those of minor importance of each group. The plan of description adopted gives an account of the tree, its botanical and common names, geographical distribution and botanical family. The sylvicultural information describes requirements as to soil and situation, sylvicultural characteristics and methods of cultivation; much of the information contained in these sections is summarised in an appendix which gives lists of trees suitable for varying conditions of environment. The practical features of the timber are then dealt with, including seasoning, working qualities, sizes and availability, and uses in industry. This main section of the book is prefaced by four useful chapters dealing with British trees and their cultivation, the properties of wood, the structure of timber and the identification of common home-grown woods, the last-mentioned being illustrated by instructive line drawings. A set of some thirty full-page photographs of home-grown timbers is a feature of this useful book, which has a classified bibliography and a full index.

S. E. C.

Photoperiodism in the Potato. By C. M. Driver and J. G. Hawkes. Imperial Bureau of Plant Breeding and Genetics. Pp. 36, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1943.) Price 2*s.* 6*d.*

POTATO COLLECTING EXPEDITIONS IN MEXICO AND SOUTH AMERICA. II. Systematic Classification of the Collections. By J. G. Hawkes, Ph.D. Imperial Bureau of Plant Breeding and Genetics. Pp. 142, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1944.) Price 7*s*. 6*d*.

The first of these technical communications—it would surely be more convenient if such publications bore serial numbers—consists of two parts. A review of the literature of photoperiodism in the potato is contributed by C. M. Driver; while the second part, by Dr. J. G. Hawkes, describes the results of an investigation of the photoperiodicity of a group of Peruvian cultivated varieties, which form part of the Empire Potato Collection at Cambridge.

Part I is presented in twelve sections, which include discussion of experimental methods, the influence of temperature on the response to light, and the effect of the photoperiod on vegetative growth, flowering and fertilisation, formation of stolons, and tuberisation. With the potato, the criterion for judging the response to length of day is the formation of tubers and the maturing of a crop, and not the attainment of sexual maturity. It appears that long, warm days with moderate light intensity provide for maximum vegetative growth. Flowering and the production of stolons seem to be stimulated by long days combined with moderate and warm temperatures respectively. Tuber formation is determined by the carbohydrates available after growth requirements have been met. Under short-day conditions more carbohydrates are available for this purpose. As regards the United Kingdom, main crop varieties, forming their tubers in a period of shortening days, are classed as day-neutral verging on short-day types. The abundant growth made during the long summer days provides for the maximum tuber growth as the day-length shortens. On the other hand British early varieties must form a crop under long-day conditions, and for these something approaching a true long-day type is required. Photoperiodism in the potato is inherited: a large number of genes appear to be involved, with those determining the short-day character apparently dominant. It is considered possible that some of the South American short-day types may be of value in potato breeding for tropical conditions, which, incidentally, may have to be based on heat-resisting species.

In the other technical communication Dr. Hawkes has produced a noteworthy contribution to potato literature. This publication directly results from the Imperial Agricultural Bureaux potato collecting expeditions in Mexico and South America of 1938 and 1939, and describes three years' work on the classification of the Empire Potato Collection. These expeditions Dr. Hawkes now suggests "represent perhaps the first attempt within the British Empire to make a thoroughly scientific and exhaustive collection

of indigenous plant material for the initiation of a large-scale breeding programme." This alone would have rendered the undertaking of outstanding interest. However, despite the fact that other collectors had previously been in the field, and doubtless on account of the careful preparation and planning of the expeditions, a number of new species were obtained. In fact Dr. Hawkes considers that very appreciable new wild potato material is still to be found in the Central American Andes.

The present work is the second of its series, an account of the expeditions having appeared already (*Potato Collecting Expeditions in Mexico and South America*. By J. G. Hawkes. Imperial Bureau of Plant Breeding and Genetics, Cambridge, 1941.) The publication opens with brief accounts of the history of potato taxonomy and the classification and phylogenetic position of potato species. The bulk of the work is devoted to the taxonomy of the specimens collected; some thirty new wild species and five new cultivated species, together with one new series, are described. The concluding sections cover the cytological investigations carried out on the collection, and discussion of the origin and evolution of cultivated potatoes. There are three appendixes giving the Latin descriptions of the new species, a list of the new species and varieties, and a complete list of the identifications of the Empire Potato Collection. Finally there are a bibliography, several maps and plates, and a large number of tables and line drawings.

In themselves both publications must have a somewhat limited appeal, confined more particularly to those directly concerned with potato breeding. However, as an indication of the wealth of material that may be made available for plant-breeding, and plant research generally, by such collections, the work to which they relate is of much more general interest. Doubtless the possibilities of similar collections with other crops will be studied in the light of the encouraging results obtained with potatoes. Finally, as the results of this work appear, it seems appropriate to recall that the original suggestion for the expeditions has been attributed to Dr. P. S. Hudson, Deputy Director of the Cambridge Bureau.

E. H. G. S.

VARNISH CONSTITUENTS. By H. W. Chatfield, Ph.D., B.Sc., F.R.I.C. Pp. xvi + 496, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill, Ltd., 1944.) Price 35*s*.

Until about the beginning of the third decade of the present century the varnish manufacturer was restricted to a very limited number of ingredients for his products. Since that date, as a result of research work, particularly in the realm of organic chemistry, he has now a very greatly increased number of materials from which to select. In consequence he is now enabled to put on the market many more types of varnishes. Probably the greatest changes that

have occurred in the recipes of the varnish maker are due to the discovery of synthetic resins. It is only natural, therefore, that the largest chapter in this book should be devoted to this new class of resins. Details are given of the manufacture, properties and uses of the different types of synthetic resins, and information is supplied as to how their properties may be modified within limits by varying the materials from which they are made or by changing the conditions of manufacture. Among the classes dealt with are included the alkyd, phenol formaldehyde, maleic, coumarone, urea formaldehyde, vinyl and acrylic resins. Another class of resins, which is also an outcome of scientific research, is that of the modified natural resins, produced by esterification of rosin and copal. A description of their manufacture, properties and uses is given in a further chapter.

The earlier chapters of the book give an account of the sources, composition, properties and uses of the oils used in varnish manufacture. Among them are included those of more recent use, such as oiticica and dehydrated castor oils. A list is supplied of the rarer oils, which might find a use for the purpose under discussion. The natural varnish resins have two chapters devoted to them, one to oil varnish resins, in which reference is made to the use of tall oil, and the other to spirit varnish resins, in which half the space is allotted to shellac, including bleached shellac and various modified shellacs. Solvents and diluents, which are important ingredients in varnish making, have some fifty pages allotted to them. Their number has increased in recent years on account of the change in the composition of varnishes. Special consideration is given to the properties of solvents and the importance of their toxicity. The subject of driers receives adequate attention and the properties imparted to varnishes by the different classes are described. Plasticisers, one of the auxiliary ingredients of varnishes, are dealt with in another section of the book. The pages allotted to these materials are devoted in the main to an enumeration of the factors which should be considered in assessing the suitability of a substance for use as a plasticiser. In other chapters constituents of lesser importance are described, such as asphaltums and pitches, waxes, rubber and chlorinated rubber.

The book contains a mass of information which will be of much value, not only to the student, but also to the chemist and varnish manufacturer. The author is to be congratulated on the concise manner in which the information is presented. The tables of constants of individual constituents are very useful, especially the one dealing with the synthetic resins. Mention must be made of the very large number (over 1,600) of references to literature which are introduced throughout the book. There are about a dozen excellent plates and the volume is completed by author and subject indexes.

G. T. B.

THE PHARMACEUTICAL POCKET BOOK. Published by direction of the Council of the Pharmaceutical Society of Great Britain. Fourteenth Edition. Pp. x + 423, 7 × 4½. (London: The Pharmaceutical Press, 1944.) Price 10s.

This pocket book is published as a reference volume to the fundamental material required in the practice of pharmacy and is recommended as such both to the student of this subject and to the practising pharmacist. The text, however, covers such a wide range of subjects that it has much information of use to those in other professions.

The fourteenth edition, produced under the supervision of the Codex Revision Committee of the Pharmaceutical Society of Great Britain, follows the same general plan as the previous volume, but has been considerably revised and expanded, while material which is now obsolete has been removed. For the convenience of those who are not already familiar with this work a brief summary of the subjects included in the volume may prove of use.

Apart from the first section of the book which deals with the Pharmaceutical Society of Great Britain, its activities and examinations, a large proportion of the text is devoted to the following subjects: The Science and Art of Pharmacy, including information on dispensing, sterilisation of medicaments, homeopathics, equivalent B.P. formulæ, doses of official medicaments, and equivalent metric and imperial doses; Forsenic Pharmacy, containing useful summaries of the Pharmacy and Poisons Act, 1933, the Poisons Rules, the Dangerous Drugs Acts, the Sale of Food and Drugs Act, 1938, and other legislation relating to pharmacy; Poisoning, including symptoms and antidotes, treatment, medicinal and fatal doses of poisons; Biochemical Analysis, dealing with the analysis of urine, blood, cerebrospinal fluid, etc.

There are sections on Hydrogen Ion Concentration, Bacteriology, Food and Diet, and also useful tabulations giving Imperial and Metric Weights and Measures, Miscellaneous Factors, Alcoholic Strengths of the B.P. Preparations, Solubilities, Thermometric Equivalents, Freezing Mixtures, Vitamin Contents of Official Preparations, Veterinary Posology, a *Materia Medica* of Vegetable and Animal Origin, and also an extensive table of Synonyms and Trade Names.

There are a few minor flaws which might possibly draw comment from a critical review of this book, but it remains nevertheless an excellent and handy book of reference.

H. E. C.

MINERAL RESOURCES

ARTICLE

AUSTRALIA'S MINERAL INDUSTRY IN THE PRESENT WAR[1]

By H. G. Raggatt, D.Sc.,
Director of the Mineral Resources Survey Branch of the Commonwealth Department of Supply and Shipping

Ready access to an adequate supply of most metals and many minerals is one of the most important essentials in the prosecution of war, but it would be wearisome merely to draw up a list of metals and minerals which are of special interest at the present time and to discuss them, one by one. I propose instead to deal with the whole field in very general terms, but to place the accent upon the little known, new and unusual rather than to divide my time according to the relative importance of the various metals and minerals.

Precious Metals

If one were seeking to compare our pre-war mineral industry with that of the present day, probably the most striking feature would be the relative unimportance of *gold* mining at the present time. In fact, but for special circumstances in individual localities there would have been a complete cessation of gold mining in Australia during the war. This has been brought about by the uselessness of gold as an industrial metal, the existence of a world-wide barter agreement among the anti-Axis nations which for the time being does not call for gold to balance trade deficiencies, and the need to employ as many men as possible in the most essential work.

The decision drastically to curtail gold mining has had its most serious effects in Western Australia, where many communities have been established, entirely dependent upon gold mines. The gold mining districts of Victoria, e.g. Bendigo and Castlemaine, have also been hard hit. Other States have not suffered so much because only in very few places in those States are there mines solely devoted to winning gold. For instance, 50 per cent. of the Queensland production is from Mount Morgan, which is also important as a source of copper.

[1] Extracted from the Clarke Memorial Lecture delivered before the Royal Society of New South Wales, June 23, 1943.

Ninety per cent. of the *silver* consumed in Australia is required for coins; 10 per cent. is used industrially. However, no mining operations can now be regarded as being carried on primarily for the recovery of silver. Some silver is obtained with gold, but the bulk of it occurs associated with lead and zinc, both of which metals are required for war purposes. It is of interest to note that 60 per cent. of the world consumption of silver is used industrially.

Australian resources of *platinum* and *osmiridium* are small and large production cannot be expected. Annual production of 200-300 oz. of osmiridium can normally be obtained from alluvial sources in Tasmania.

Fuels

Australia possesses adequate supplies of *bituminous coal* for some considerable time to come. These supplies, however, are not nearly as large as is popularly believed. Nearly all of them are close to the coast and it will be realised that this distribution has been an important factor in accentuating population distribution in the coastal areas. The principal deposits of bituminous coal are in Queensland and New South Wales. Reserves of coal available in these two States are probably approximately equal.

The production and distribution of coal won in New South Wales are the outstanding features of the industry and transport of coal from New South Wales to the other States has presented a major problem to the responsible authorities. These difficulties have directed attention to the possibility of development of coal deposits considered relatively unimportant in pre-war years, but which, if developed now, would release transport for other purposes.

Victoria is badly off for bituminous coal, but the sub-bituminous coal of Wonthaggi has come in useful in the present emergency. This coalfield is a maze of faults which makes mining costly and difficult.

In the hope of releasing transport now engaged in carrying coal from New South Wales to the Riverina and Victoria, attention has recently been directed to the Coorabin-Oaklands coalfield. Supplementing the work done earlier by the New South Wales Mines Department and private interests, a considerable amount of boring has been done on behalf of the Commonwealth Coal Commission. As a result it has been concluded that the field has interesting possibilities, but that it could not be brought into production quickly on a scale large enough to be of much assistance in the present emergency.

Tasmania has several areas of bituminous coal, and production has been augmented during the war to meet increased demands. This has been achieved with only slight addition to the labour force engaged. Production in 1942 was 134,442 tons. Importation of New South Wales coal amounting to about 100,000 tons is still required for gas making and special steam raising purposes.

Difficulty in obtaining sufficient supplies of New South Wales coal has forced the South Australian authorities to give attention to the Leigh Creek (Copley) field. Leigh Creek is situated on the North Australian railway 165 miles north of Port Augusta in an area where large supplies of water are difficult to obtain. The coal from this field is a low ranking sub-bituminous type and its industrial application is going to be difficult. However, prospecting of the field has been pursued with great vigour by the South Australian Government and the field is now being developed.

The State of Western Australia has very large areas occupied by sediments of the same geological age as those in which the major coalfields of Queensland and New South Wales occur, but unfortunately in their areas of maximum development these sediments do not include coal of commercial quality and thickness. The coal produced from the Collie district in the south-west part of the State, however, is a very useful fuel and sufficient is produced to satisfy most of the State's power and transportation requirements.

Even were the resources of black and near-black coal in States other than Queensland and New South Wales fully developed, those States would still require a certain amount of coal from New South Wales or Queensland for gas making and some special steam-raising purposes.

The *lignite* resources of Victoria have been very thoroughly investigated by the Victoria Mines Department and the State Electricity Commission. Total known reserves are very large, but much of this is under deep cover. A great State-owned electricity generating station and briquetting factory are based on these deposits at Yallourn.

Considerable reserves of lignite have also been proved in South Australia, but are undeveloped.

A fundamental weakness in the Australian economy is our lack of resources of *liquid fuel* or adequate substitutes therefor. Parenthetically it may be remarked that this weakness goes side by side with lack of large surface water resources for the generation of electric power. Australia has about the same area as the United States (Alaska excluded) and it has been suggested that industrial development of this country comparable with that of the United States can be expected in the post-war years. I am, I hope, a patriot, but when I consider the vast coal, oil and water resources of the U.S.A. and compare them with our own, I know that this cannot be, on the basis of known sources of fuel supply. Broadly our coal and water resources are known and the necessity for making an exhaustive survey of our petroleum possibilities is thus shown to be of paramount importance. Australia has never had a policy on petroleum exploration, but it will be forced to have one when the war ends.

It must be admitted that, so far, the search for oil in Australia

and the nearby islands has been disappointing. It is also true, however, that, with some notable exceptions, it has not been exhaustive. The most intensive studies have been made by private companies, e.g. the Australasian Petroleum Company in New Guinea and Papua, the Shell Company in Queensland, and Caltex (Aust.) Limited in Western Australia. The first of these had reached a stage where boring was in progress when the war began. Some commendable work, involving mapping of large areas, has also been done by the relatively small Australian companies, Oil Search Limited and Freney Kimberley Oil Company.

The search for oil in Australia is now virtually suspended, partly because some of the most promising regions are within a combat area and partly because it is realised that in most of the potentially oil-bearing areas a long programme of survey, prospecting and development is required, and the results could have no bearing on the present conflict. An exception is the Lakes Entrance district in Victoria, where oil has been proved to be present in a glauconitic sandstone (of Middle Miocene Age) extending over an area of 8 sq. miles at an average depth of about 1,200 ft. The proving of this area has been done mainly by small companies, but the State, and State and Commonwealth together have also assisted. Fortunately the area was brought under the control of one company, Austral Oil Drilling Syndicate, in 1940. This syndicate is to be congratulated for its efforts in collecting, collating and preserving all drilling data it was able to acquire. The central section of this area is to be developed by application of the method recommended by Mr. Leo Ranney (1941), which consists in drilling horizontal holes radially from a circular vertical shaft. The sinking of the shaft is in progress under the joint direction of the Commonwealth and Victorian Governments.

The *torbanites* (*kerosene shales*) and *oil shales* of New South Wales, Queensland and Tasmania offer some possibilities of oil production. Interest at present centres in the Glen Davis project which recently formed the subject of a report by the Commonwealth Parliamentary Committee on Public Works.

Australia never seems to have regarded her *natural gas* possibilities seriously. The main interest attaches to gas supplies near large industrial centres and probably this industry will follow the usual stages. Potential consumers will begin to realise that in natural gas they have a convenient fuel near at hand, and from this beginning its use will spread. It will be realised also, that with proper technique, large supplies of gas can be obtained over long periods from natural reservoirs, thus justifying capital outlay on pipe lines. Some industries will ultimately realise it may be to their advantage to establish themselves near gas supplies.

Regional surveys and reconnaissance drilling for natural gas have been suspended for reasons similar to those mentioned under the heading of petroleum, but an interesting experiment is in

progress at the Balmain Colliery, City of Sydney, which has reached a decisive stage.

At the Balmain Colliery coal has been developed from vertical shafts nearly 3,000 ft. deep. From these shafts, workings extend underneath Sydney Harbour. When the colliery was working, the amount of gas liberated per ton of coal mined was 2,500 cu. ft. This is a very high yield. Recent investigation showed that despite the fact that seals placed in the workings when mining ceased in 1931 were broken, and that there was therefore free movement of air through the workings, they were full of gas and even under these conditions the gas had a calorific value of over 900 B.Th.U. It was therefore demonstrated that under static conditions a coal face will exude gas for a long time.

Seals have been erected in the colliery so that it will be completely air-tight, and methane gas is being extracted from the workings by putting a vacuum on a pipe leading from the workings to the surface. The result of the experiment depends of course upon the length of time during which gas will continue to be given off by the coal face, and the rate of yield. At present 100,000 cu. ft. of methane with a calorific value of 960 B.Th.U. (equivalent to 1,000 gallons of petrol) is being marketed per week and used as a petrol substitute. The fact that the Balmain colliery is situated within the City of Sydney and that marketing of large quantities of gas will present no difficulty, made this experiment especially well worth doing. It is to be hoped that if the experiment is successful other similar prospects will be brought into production.

At a later date it is hoped that Mr. Leo Ranney's (1941) scheme of degasifying the coal in the Balmain Colliery will be tried. This scheme has two objects: to produce methane gas for use as such, and to degasify the coal and so make working conditions safer.

Iron and Steel

Our iron and steel industry is based chiefly upon coal produced in central-eastern New South Wales and iron ore produced from the Middleback Ranges in South Australia. Owing to the difficulties of maintaining shipments of coal and iron between these points it has been found necessary to draw upon the many somewhat small deposits of iron in New South Wales. Cadia, Crookwell, Breadalbane, Tirranna and Michelago are some of the centres from which supplies are being drawn to help keep up Australia's output of steel.

There is a lesson to be learned here, namely, that the value of a natural resource is not a static thing; geographic position and changing circumstances may be, and often are, more important than any intrinsic worth the resource itself may possess. Some people were inclined to scoff at the re-surveys of New South Wales iron ore resources made in the years immediately preceding the war. But this audience would be surprised if I could say what proportion of Australia's steel requirements are being met from sources in New

South Wales. Surveys of mineral resources should therefore be comprehensive, thorough and continually subject to revision.

Steel is the basic metal in war and, fortunately, far-sighted men have seen to it that Australia has a strong and efficient steel industry. Without this, our munitions effort could not have been made. It was only in 1915 that the Broken Hill Proprietary Steel Works were opened. "To-day, Australia can produce steel more cheaply than either Great Britain or the U.S.A. Within the short period of twenty-five years Australia has become self-sufficient in steel. Her production *per capita* is roughly equal to that of Great Britain and more than double that of Japan. Only Germany and U.S.A. can claim a higher *per capita* production." These words are taken from a recent statement by Mr. H. G. Darling (1943), Chairman of Directors of Broken Hill Proprietary and we would do well to note the basic economic factor to which Mr. Darling attributes our success in steel making, namely, the ready availability of coal and iron ore at or near tidewater.

Ferro-Alloys

The outstandingly important metals of the ferro-alloy group are tungsten, molybdenum, manganese, chromium. Nearly all the deposits of the first three of these metals in Australia are of the vein or pipe type which do not lend themselves to large-scale production. Most of the chromium deposits are small and irregular. Hence production curves for these metals show sharp fluctuations, the peaks representing discoveries of easily worked deposits, soon depleted, plus a response to the stimulus of high prices ruling in the last war.

There are exceptions to the foregoing generalisation, including the scheelite deposit at King Island, the deposits of *manganese* at Pernatty Lagoon, South Australia, and the well-known deposits of manganese at Horseshoe, and *chromite* at Coobina, Western Australia. Both the latter constitute a valuable reserve, but have not been worked, chiefly because of the high transport costs involved and because sufficient high-grade chrome ore has continued to be available from New Caledonia, and sufficient manganese ore for metallurgical purposes has been available until recently from Pernatty Lagoon. It is now believed the latter deposit is virtually exhausted and it has therefore been necessary recently to import ore for metallurgical purposes.

When the war began it was thought unlikely that we would be able to obtain within Australia adequate supplies of high-grade manganese ore (pyrolusite) suitable for use in dry batteries. There are no large deposits of ore suitable for this purpose known to exist in Australia, but it now seems possible that sufficient ore will be available from a number of small deposits in Papua, Queensland and New South Wales to meet requirements. Recent work by the Ore-Dressing Laboratory of the New South Wales Mines Department

suggests that simple methods of beneficiation can be applied to ores mined in the Tamworth district (which are known to be suitable for use in batteries but which are somewhat low in MnO_2 content) and perhaps also to similar ore from northern Queensland. Papuan ore is satisfactory without treatment but the ore bodies are believed to be small and mining and transport difficulties are, of course, difficult to overcome at the present time.

High prices and a strong demand have had little effect upon production of *molybdenite*, and no really large sources of supply are known. Production is increasing, however, and the deposits now being developed at Wonbah in Queensland, Whipstick in New South Wales and Everton in Victoria should provide useful increments to output in the near future.

By overrunning part of China, Thailand and Malaya the Japanese obtained access to abundant supplies of wolfram, and thus effectively cut off the allied nations from access to the principal sources of *tungsten* ore. In 1939 world production of tungsten concentrates was about 33,000 tons, of which 60 per cent. came from China and adjacent lands, 10 per cent. each from Portugal, Bolivia and the United States, and 3 per cent. from Australia and Argentina.

Early in the war the prospects of really large production of tungsten concentrates from Australia were not hopeful, but the outlook has been completely changed by the results of a diamond drilling campaign on King Island, Tasmania, completed a few months ago. This was done on the recommendation of the Minerals Committee following a report by Messrs. Mawby and Nye. The King Island deposit is now shown to be one of the largest of its kind in the world. It can, moreover, be developed by open cut methods and everything is now being done to increase output. It is greatly to be regretted that the size of this deposit was not realised earlier, but there is no blame attaching to anyone for that. The deposit is a disseminated type and its size could only be determined by a costly diamond drilling campaign. The planning of the development is the responsibility of the Controller of Minerals Production, acting as adviser to the King Island Scheelite Company. This seems to be a case where " Government interference " has had useful results.

Until full-scale development is reached at King Island, requirements must be met by existing production from that source and other smaller ones, chief of which are the Aberfoyle and Storey's Creek mines in Tasmania, the Hatches Creek and Wauchope Creek fields in the Northern Territory and the Wolfram Camp area in Queensland. There are, of course, many other small producers, most of them in eastern Australia.

Base Metals other than Iron

The principal metals dealt with under this heading are lead, zinc, copper and tin. As all current production of cadmium and cobalt in Australia is obtained as a by-product from the treatment

of zinc concentrates those two metals are also dealt with in this section.

Tin.—The overrunning of Malaya and Burma by the Japanese and their blockade of China cut off the Allied Nations from large supplies of zinc and tin. Of the estimated tin content of ores produced in 1940 (231,700 tons) 70 per cent. (160,687 tons) came from the Malay States, Netherlands East Indies, Siam, China, Burma and Indo-China. It must also be remembered that nearly 60 per cent. of the world's production of tin was smelted in this region.

That this position might arise had been anticipated to some extent and stocks had been built up. Steps had also been taken to increase smelter capacity, especially in the U.S.A., where arrangements were made to handle Bolivian concentrates.

In the period 1873-1882 (except for two years) Australia held first place among tin-producing countries. Her production was approximately 11,500 tons per annum, representing 25 per cent. of the world total. In 1939 Australia's production was approximately 3,600 tons. Naturally everything possible has been done to increase output since that year and rationing has been applied to civil uses.

Tin is produced in Australia from both veins and alluvial deposits and production is about equally divided between Queensland, New South Wales and Tasmania. Since much of the tinstone won in Queensland and New South Wales is obtained by a large number of small producers, factors to which I shall refer in closing this address have had most serious effects on output. Fortunately these are gradually being overcome and good progress has been made in bringing new production into effect. The Tableland Tin Company's dredge is now operating in the Mount Garnet district, Queensland, and is expected to produce at the rate of 1,000 tons of metal per annum. A dredge is also being assembled on the Dorset Flats in north-east Tasmania and increases may also be expected from some of the regular producers. (It is interesting to note here that the dredge at Dorset Flats has been taken from a former gold producing property.) Just as we have been very fortunate in having a scheelite deposit of the magnitude of King Island so it seems fortunate that the Mount Garnet area in northern Queensland is commencing production at a rate which will relieve any anxiety with regard to tin supplies in Australia and allow some export.

Copper.—It may come as a surprise to many who remember the old copper mines of South Australia, northern Queensland and central New South Wales that Australian production of copper is far below consumption. This, of course, is largely a reflex of our greatly expanded munitions projects.

The number of mines which made noteworthy contributions to Australian copper production in 1939 were few and Mount Lyell was easily the largest source. It may be noted incidentally that Mount Lyell reserves are nearly 15 million tons of 1·14 per cent. ore.

This year (1943) the story will be very different, owing to developments at Mount Isa. Production of copper (metal) commenced at this mine in April 1943 and it is estimated that by the end of the year the monthly production will be approximately equal to that of Mount Lyell. Proved reserves at Mount Isa amount to 1½ million tons of 3 per cent. ore, but the limits of the orebody have yet to be defined.

The Mount Isa mine is known as a large producer of lead, zinc and silver and it must be considered very fortunate that two large orebodies should exist side by side in such a way as to enable them to be developed from the one set of main workings. It is further remarkable that the one orebody contains little copper and the other no lead or zinc. The copper-body is also free from other deleterious metals so that much of the copper produced will probably not require electrolytic refining, but can go into industry as "fire-refined." The Mount Isa copper lode does not outcrop. It was discovered by diamond drilling into the hanging wall of the lead-zinc orebody and has been outlined from level to level by this means.

The production of copper at Mount Isa has only been achieved at the expense of that of lead and zinc (because of manpower difficulties) and it has not been possible to man the other copper mines in the district.

Another interesting war-time development relates to changes in smelter practice at Port Pirie. Before the war, the amount of lead present in copper matte received at Port Kembla from Port Pirie governed the amount of lead-bearing copper matte and concentrates Port Kembla could accept for treatment. One effect of this was, for instance, that copper produced from Captain's Flat was lost to Australian consumers. Improved smelter procedure at Port Pirie, however, has changed all that. Port Kembla can now not only take the whole of Captain's Flat's production of copper concentrates, but copper-bearing ore from Mount Gunson, South Australia, has gone to Port Pirie in place of barren sandstone flux, and Read-Rosebery mines are enabled to mine ore containing a higher percentage of copper than was formerly possible. This must be acclaimed a noteworthy and opportune technical achievement.

Lead and Zinc.—Earlier I referred to the loss of zinc occasioned by the Japanese overrunning Burma. The extent of this loss may be realised from the fact that Burma Corporation Limited, operating the Bawdwin mines, produced 59,500 tons of concentrates in 1939, i.e. twice the normal annual production from Mount Isa mines.

Fortunately, contributions of lead and zinc which Australia can make to the United Nations war effort are considerable, but as production comes from a few well established mines, little discussion is required. The most important producing centres of lead and zinc are Broken Hill district and Captain's Flat in New South Wales, Mount Isa mines in Queensland and the Read-Rosebery mines in Tasmania. In addition, approximately 2,500 tons of lead are

produced from Mount Farrell in Tasmania. The relative importance of these centres may be gauged from the following production figures for the year 1939 (in long tons):

	Lead.	Zinc.
Mount Isa	45,265	29,041
Broken Hill	204,692	145,434
Captain's Flat	7,145	11,425
Read-Rosebery	8,515	25,021
Mount Farrell	2,365	—

It has already been pointed out that, because of the greater necessity to produce copper for home consumption, it has been necessary to divert men from the production of lead and zinc at Mount Isa to copper, but the output of lead and zinc from the other three main centres is still very considerable. In fact, despite all difficulties, production of both metals is above the previous record levels which were realised immediately prior to the first world war. If a special effort were needed to increase production of either or both of these metals, the only essential requirement is additional manpower, as reserves and all the necessary facilities for mining and treatment exist.

The Broken Hill orebody, besides yielding large quantities of silver, antimony, copper, lead, zinc and gold, is also our only present source of *cadmium* and our main source of *cobalt*. Both these metals are recovered in the Electrolytic Zinc Company's plant at Risdon, Tasmania.

Light Metals

Magnesium is produced by the Broken Hill Proprietary at its Newcastle works. Magnesite mined in New South Wales is used and the metal is produced by thermal reduction of calcined magnesite with calcium carbide. Though production commenced only in 1941, for a time some metallic magnesium was exported to Great Britain, but this has now ceased owing to the increase in our own consumption. Substantial quantities of calcined magnesite have, however, gone forward from New South Wales to the United Kingdom. Australian reserves of magnesite are fairly large, the principal deposits being situated in New South Wales, South Australia and Western Australia, and there are also large deposits of dolomite available in Queensland, New South Wales, Tasmania and South Australia.

It is most unfortunate that the manufacture of *aluminium* had not been commenced in Australia prior to the war. At that time, however, New South Wales was the only State which had made a survey of its resources of *bauxite*, the principal ore of aluminium.

In eastern New South Wales there are proved reserves of 15 million tons of bauxite containing from 34 per cent. to 45 per cent. alumina and from 1·76 per cent. to 5·47 per cent. silica. The deposits occur in two main groups, Emmaville-Inverell and

Bundanoon-Wingello, the former being the higher grade. All the deposits are easily accessible and have little or no overburden. Though somewhat lower in grade, the Bundanoon deposits might be preferred to the others because of their nearness to black coal (which is required in the ratio of 1 ton to 1 ton of alumina), fabricating plants and shipping facilities.

Victoria possesses the highest grade bauxite in Australia. Formerly believed to be very small, the reserves are now known to be considerable. For this development our thanks must go chiefly to Sulphates Pty. Limited. It is this company which has discovered most of the bauxite deposits and these discoveries are continuing. A considerable amount of test boring and shaft sinking has been done by the company. The Victorian Mines Department has one of its boring plants operating in the Boolarra district and two deposits near Mirboo North have recently been tested by the Controller of Minerals Production on the recommendation of the Minerals Committee. As a result, proved reserves are now known to exceed 650,000 tons. Of this amount, 500,000 tons are known to average about 52 per cent. alumina and 5 per cent. silica. Details concerning the remainder are not yet available. This ore is readily amenable to simple methods of beneficiation, if this were considered necessary. The main deposits are situated in the Mirboo-North Boolarra district, 80 miles E.S.E. of Melbourne and 20 miles by air line S.S.W. from the State Electricity Undertaking at Yallourn. All are easily accessible. The largest individual lens of bauxite so far discovered in Victoria contains about 200,000 tons. The ratio of overburden (chiefly sands with some clay and lignite) to ore is somewhat less than 4 to 1. The discoveries so far made by no means exhaust the possibilities of this one district, so that it cannot be doubted that the total reserves available in South Gippsland must be fairly considerable.

Bauxite was not discovered in Tasmania until late in 1941. The original discovery was made in the Ouse Valley, and though other discoveries have since been made, the Ouse bauxite has turned out to be the highest grade so far known in Tasmania. An area 2 miles N.N.W. from the village of Ouse, selected by the Tasmanian Department of Mines for testing has been proved to contain 500,000 tons of bauxite with 41·2 per cent. "free" alumina and 3·2 per cent. silica. The average thickness of bauxite and overburden are respectively $8\frac{1}{2}$ and $3\frac{1}{2}$ ft. The deposits are conveniently situated near coal, water and hydro-electric supplies.

I have very briefly reviewed the general setting of Australia's main known higher grade resources of bauxite. I think you will agree that the general setting is very favourable and that there seems no reason why Australia should not be able to produce aluminium at a price at least equal to that at which it can be imported. You may ask what this has to do with the subject of my address. For answer I would say that our near escape from blockade,

if not invasion, ought to point the moral of a country dependent mainly upon air power for its defence depending upon sea-borne traffic for its supplies of the metal with which aeroplanes are built. And further, the faith and industry of a very few people have been responsible for building up the favourable economic picture we now have, chiefly during the war years. It is pleasing to note, therefore, that the Commonwealth Government has decided to allocate £3,000,000 for the establishment of the ingot aluminium industry in Australia.

My Western Australian friends will say that all this insistence upon the eastern States' bauxite is unfair to their claims for *alunite*. That is not so. Nearly all the world's aluminium is made from bauxite, and that is the only basis upon which a comparison such as I have made is possible. The Lake Campion alunite deposit is an unusual type. Most of the world's alunite deposits are vein-like, and the limited reserves, costs of mining, apart from the difficulties in treatment compared with bauxite, have made them relatively unattractive as a source of aluminium. The Lake Campion deposit, however, is very different. It is a lake filling containing not less than 2 and probably more than 10 million tons of alunite mud. The alunite content of the mud is approximately 60 per cent. A plant has been erected for the recovery of a product containing 75 per cent. sulphate of potash and 25 per cent. sulphate of soda at the rate of 5,000 tons per annum and it is hoped to expand this production over a period of years to meet Australia's requirements.

The residues from the potash plant will contain about 46 per cent. alumina and 37 per cent. silica. A pilot plant is being erected (which will make use of acids generated in the potash plant) with the object of finding out whether alumina suitable for the manufacture of aluminium can be prepared from this residue.

Considerable interest has been shown in *beryl*, chiefly for export to the United States. A relatively large mass of beryl occurs closely associated with the tantalite deposit at Wodgina and the major domestic production is exported from that source. There is also some production from the Mount Isa district in Queensland.

Antimony and Arsenic

Antimony and arsenic may be conveniently dealt with together because, in recent years, the bulk of Australia's production (apart from antimony recovered from Broken Hill ores) has been produced from mines in the Wiluna district, Western Australia. After 1943, however, the picture will change materially as the antimonial bodies at Wiluna will have been worked out. The other sources of supply are relatively small stibnite-bearing veins found in many parts of eastern Australia. Antimony in the Broken Hill concentrates is recovered as antimonial lead. Australia is self sufficient in antimony and is an exporter of arsenic, but it may be noted that

half the world's pre-war production of antimony came from China and adjacent countries.

The principal sources of supply of arsenical ores apart from Wiluna are situated near the Queensland-New South Wales border. Several of them were worked when arsenical sprays were being used in large quantities for control of prickly pear.

Tantalum and Columbium

A special effort is being made under the direction of the Controller of Minerals Production to develop the Wodgina deposit in Western Australia both for tantalite and beryl. It is anticipated that small parcels of tantalite will also be produced from other localities in Western Australia and the Northern Territory and possibly Queensland.

Beach Sand Minerals

It is only comparatively recently that the heavy minerals present in the beach sands along our east coast, chiefly adjacent to the Queensland-New South Wales border, have been exploited. The principal minerals of economic value present in these sands are zircon, rutile, ilmenite and monazite. Garnet is also present, but no commercial use has been found for it so far. Because it contains a small amount of chromic oxide, the ilmenite also has limited use. The problem has been, therefore, first to delineate the areas where the best accumulations of naturally concentrated sands occur, and second, to evolve a method of treatment to yield as clean concentrates as possible of zircon, rutile and monazite. The treatment problem is not particularly difficult and has been solved by the application of tabling, flotation and electro-magnetic separation.

There is a growing consumption of zircon and rutile within Australia. The bulk of the production, however, is exported to the United States of America.

Most of the zircon is used both at home and abroad in the manufacture of ferro-silicon-zirconium with minor amounts in enamel ware, spark plugs, and electrical appliances. The rutile and rutile-ilmenite mixed concentrates, on the other hand, are used mainly for welding rod coatings and secondarily for ferro-titanium. The manufacture in Australia of flints (ferrocerium) using monazite has commenced or is about to commence.

So far this industry has met all the demands made upon it.

Sulphur, Sulphides and Sulphuric Acid: Phosphate Rock

A most important aspect of our mining industry is that concerned with the production of sulphuric acid and sulphur from raw materials available in Australia.

Australia normally obtains its supplies of sulphur from imports of native sulphur (recently almost wholly from U.S.A.), roasting

of sulphides (pyrite-marcasite and sphalerite-marmatite), and spent oxide from gas plants (about 300 tons sulphur per annum).

The bulk of the sulphur is used in the manufacture of sulphuric acid, which in turn is used to make superphosphate.

Since Australia produces a large surplus of sulphide concentrates, much of which is wasted and which can be used for the manufacture of sulphuric acid, it would appear that most of the sulphur imported can be replaced by home produced sulphide concentrates.

As the average annual value of the sulphur imported into Australia for seven years before the war was £438,000, it is a business well worth diverting to home industry. The desirability of doing this has long been recognised and has been assisted by the Commonwealth Government by the payment of a bounty on home-produced sulphur since 1923. There are practical difficulties to be overcome in this substitution, but they are not insurmountable. Ultimately the deciding factor is, of course, the cost of superphosphate. Considerable substitution had occurred before the war and this has continued, the most notable new development being the use of pyrite concentrates from Norseman in substitution for imported sulphur in Western Australia. Since the British evacuation of Nauru and Ocean Island there has been drastic rationing of phosphate rock, and this in turn has meant that less sulphuric acid has been required for the manufacture of chemical fertilisers. The combination of shortages of both sulphur and phosphate rock has thus facilitated the process of substituting sulphide concentrates for sulphur in sulphuric acid plants.

There is a good deal of unnecessary transport of sulphides produced in Australia and the transportation of pyrite concentrates, 50 per cent. only of which is sulphur, is also wasteful in itself. The ideal would be to manufacture elemental sulphur from sulphide concentrates in sufficient quantity to satisfy such requirements. Another alternative would be to transport acid, but that is very difficult. Australian producers of sulphides and especially those interested in the manufacture of sulphuric acid, are well aware of the advantages of transporting sulphur as compared with sulphides and it is believed that ultimately elemental sulphur will be produced in Australia in sufficient quantities to satisfy all domestic requirements.

Phosphate Rock.—The Australian farmer has been encouraged to use the highest grade superphosphate fertilisers, and when war began consumption of such fertilisers had reached a high figure. For its phosphate this fertiliser industry depended upon high grade rock from Nauru and Ocean Island, both of which are now in Japanese hands. In the year ended June 30, 1939, imports from these sources amounted to 800,422 tons, valued at £829,061.

Loss of this phosphate is likely to have serious consequences upon certain phases of our pastoral and agricultural industries; hence the necessity for intensive prospecting and development of

our indigenous resources. There seems little prospect of producing much phosphate rock in Australia, suitable for use in the manufacture of superphosphate, but considerable quantities of lower grade rock containing about 40 per cent. tricalcic phosphate and 10 per cent. ferric oxide and alumina are available in South Australia.

Arrangements for using the small quantities of guano and phosphate rock still available on the Abrolhos Islands, Western Australia, are well advanced and a thorough investigation is being made of the deposits in the Dandaragan district in Western Australia. At this locality a reserve of 100,000 tons of rock with 25-35 per cent. tricalcic phosphate has been proved. The phosphate occurs as nodules in a zone up to 4 ft. thick under relatively high overburden. Commercial use of this rock is obviously going to be difficult.

Phosphate deposits are being investigated also at Holbourne Island, Queensland, Molong-Canowindra, New South Wales, and Mansfield, Victoria, but the prospect of worth-while production from them is not viewed very hopefully.

Phosphate rock sufficient for the production of high-phosphorus pig iron is available in South Australia.

Non-Metallics

With a few notable exceptions the non-metallics group is apt to escape notice, especially in wartime, when attention is focused on the implements of war and thus on steel, aluminium and the metals generally. Compared with our metal industry our non-metallic industry is only a healthy baby.

War demands and restrictions of imports have led to a greatly increased demand on domestic sources of supply of most non-metallic minerals. It is desirable that as much of this trade as possible should be retained after the war. The responsibility for this rests mainly with the producer and the processor (whose attitude to the problem is, however, governed to some extent by the volume of trade in individual minerals), but Government can and is doing much to establish production of many of these minerals on a sound basis. So far there is so little beneficiation practised that we are virtually trying to replace the carefully prepared article imported before the war with processed raw minerals.

In looking through the list of non-metallic minerals it will be found that most of them are required for the same purposes in war as in peace. They are not required directly for arms and munitions but have some vital use in industrial production or in the manufacture of some article or articles the need for which is thrown into sharp relief by the war. Perhaps the micas and quartz crystals are outstanding examples.

Mica.—Seventy-five per cent. of the world's pre-war production of muscovite came from India and 10 per cent. from the U.S.A. Practically all the phlogopite came from Canada and Madagascar,

which countries have been in keen competition, with Madagascar leading in recent years.

Muscovite and phlogopite have rather different uses; the former is chiefly now required for spark plug wrappings and radio condensers, the latter chiefly for heat insulating washers on spark plugs, though it is also used as a wrapper in some types of plugs. It will be realised that the enormously expanded aircraft industry calls for greatly increased quantities of high quality sheet mica. At the same time the prohibition placed on the manufacture of such articles as radiators, toasters and flat irons increases the cost of producing mica by taking away an outlet for somewhat inferior sheet.

The principal muscovite deposits occur in the Harts Range and along the Plenty River, distant respectively 150 and 200 miles north-easterly from Alice Springs. Other deposits to which attention is being given are those at Morehead River, 100 miles north-west of Laura, Mount Kitchin, 40 miles west of Mungana, and Yinnietharra, on the Gascoyne River, 150 miles east of Carnarvon. Phlogopite is being mined at Strangeways Range, 42 miles east-north-east of Alice Springs. Nature certainly contrived to put all these deposits in out-of-the-way places.

Muscovite has been produced from central Australia since 1890, but mining was only intermittent until 1928. The mining of phlogopite is a wartime development.

A feature of mica pegmatites not generally recognised is their extreme irregularity. This is not invariably so, but it is true of a great number. When in addition it is remembered that the distribution of the mica within the dyke is sporadic and that there is a very large amount of waste it will be realised that high quality mica is a valuable commodity, especially in the larger sizes. Prices ruling in Australia have been fixed by the Prices Commissioner and range from 2*s*. 3*d*. per lb. for spotted mica and washer size (not less than 1½ sq. in.) to 60*s*. per lb. for clear mica of special size (not less than 60 sq. in.).

The mica mining activities in the Northern Territory are now under the control of the Allied Works Council with the Controller of Minerals Production providing technical advice. The Department of Supply and Shipping is now the sole mica purchasing authority in Australia.

Quartz crystals are very much sought after these days. The molybdenite-bearing pipes of the Glen Innes district, New South Wales, offer the best chances of production, but many other prospects are being explored.

Australia's requirements of amorphous and of some kinds of fine-grained flake *graphite* are being met chiefly by production from Collinsville in Queensland and Uley in South Australia, but it is still necessary to import most if not all our requirements of crystalline and of higher grade and coarser grained flake.

The domestic demand for lower grade *barite* and *talc* (including steatite and pyrophyllite) can be satisfied from sources in South Australia, Western Australia and New South Wales, but there is a great need for supplies of the higher grades of both minerals. If this need can be satisfied there is a good prospect of the trade being held after the war.

In the ceramic industry most requirements of *clay* are being filled, but there is a strong demand for a good plastic refractory clay. The greatly increased production of *felspar* is coming chiefly from Coolgardie, Broken Hill and Gumeracha.

Some paint manufacturers (and paint is important in the war effort) are greatly in need of good yellow *ochre*. The fact that supplies of ochre are still being drawn from Rumbalara in the Northern Territory is both a tribute to the quality of that deposit and evidence of the need. Considerable reserves are believed to be available in this locality.

Fluorite is available in sufficient quantities and research is proceeding in the preparation of synthetic cryolite therefrom, which will be required when the manufacture of ingot aluminium commences.

Asbestos.—There are large reserves of blue asbestos (crocidolite) in the Hamersley Range, Western Australia, and supplies are coming forward from this source in adequate quantities. There are also ample supplies of white amphibole asbestos, chiefly anthophyllite from Bindi Bindi in Western Australia and tremolite from the Lewis Ponds area in New South Wales. The amounts of blue and white amphibole asbestos produced in Australia in 1940 were considerably larger than in any previous year.

Very large importations of chrysotile asbestos, however, are still necessary. In the year ended June 1939 these amounted to 9,217 tons, valued at £178,494, and were obtained from Canada, Rhodesia and the Union of South Africa. Local production, though small, shows a rising tendency. A new development is the formation of a subsidiary company by Colonial Sugar Refining Co., Limited, to work chrysotile deposits between Zeehan and Renison Bell, Tasmania.

The aluminium silicates, chiefly *sillimanite* and *kyanite*, are in demand as refractories. Australia is self-sufficient in sillimanite, supplies of which are obtained from Broken Hill, New South Wales, and Mount Crawford, South Australia. Some kyanite deposits in Northern Territory and South Australia have been investigated lately, but it seems as though we shall have to continue to rely on imports of this mineral from India unless sillimanite can be wholly substituted therefor. Trial parcels of sillimanite have been sent to the United States and a small export trade may result. Our known reserves are not large enough to permit other than limited export.

In Queensland and New South Wales there are considerable reserves of *diatomite* in which *Melosira* is the principal form present.

The Victorian diatomites are much more suitable than those of other States for filtration uses, but, unfortunately, reserves are believed to be small. Something might also be done with the deposits of Recent Age in Western Australia and some interesting material has recently been received from northern Queensland and South Australia, but the outlook for large-scale substitution of Australian diatomite for imported Californian for the most exacting filtration requirements is not particularly promising. However, diatomite requirements for all uses other than filtration can be supplied without difficulty from New South Wales and Queensland.

The amount of diatomite consumed in Australian industry is quite considerable, being about 7,000 tons, of which somewhat less than half has been imported. Production of diatomite has markedly increased in the past ten years.

Some General Considerations

There is no doubt that in respect to knowledge concerning her resources of many metals and minerals Australia was caught at a great disadvantage compared with say, Canada, India and U.S.A., all of which countries have national Geological Surveys and two of which have a Bureau of Mines as well. The most sketchy statements had to be compiled concerning these and other metals and minerals, which ought to have been ready before the war commenced. The essentials of this information ought to have been available in advance. I know I run the risk of being suspected of being a propagandist for my own ends, but I am prepared to run that risk because I am so certain that what I have said is true. And what is true in war should be true in peace-time. Demands usually do not arise so sharply in peacetime and the need may be less obvious, but they are there nevertheless.

In this war calls have been made upon Australia by the Allied Nations for production of certain minerals and metals. In some instances long delay has been caused because insufficient information was available upon which to base an answer or plan a production programme. Recently the outline of a plan to establish a United Nations Relief and Rehabilitation Administration has been released by the Australian Prime Minister. This plan clearly visualises pooling and sharing of resources along much the same lines as is being followed during the war. If the organisation there proposed comes into being it will be absolutely essential that information concerning all Australia's resources shall be available through unified channels.

Part of the job of the Branch which I direct has been, in conjunction with the Controller of Minerals Production and Minerals Committee, and, of course, the State Mines Departments, to make a survey of certain of Australia's mineral resources. This work is full of absorbing interest and the most aggravating complexities. The Mines Departments of the States have a very good knowledge

of mineral resources within their own borders, but something more than that is required for the planning of Australian industry. We want to know as much as possible about our mineral deposits on an Australian as well as a State basis. We also want to know what happens to the products of the mining industry. Until recently this has been nobody's business. Take a common commodity such as clay. A clay produced in New South Wales is sold to an agent in Victoria. So far as New South Wales is concerned that is the end of the story; Victoria is not interested and, in fact, is probably unaware of the transaction. By tracing what happened to the clay we find half of the production was used to make telephone insulators in Victoria and the other half found its way into a paper mill in Tasmania. Knowing that the clay is used for such purposes we are able to advise likely consumers. This is one way in which the Commonwealth supplements the work of the States and assists the development of their mineral industries.

Another most important aspect of mining in the present war may be conveniently stressed here and that is—manpower. In the war of 1914-1918 there was nothing like the call upon Australian manpower as in this. Hundreds of prospectors, gougers and small-scale miners were left free to pursue their activities and under the stimulus of high prices these men contributed valuable quantities of ores of tin, tungsten, molybdenum, copper and other metals. This condition not only does not pertain to-day, but the mining industry has had to compete with others for men, machinery, transport and all essential supplies. These remarks are not made in a spirit of criticism but merely to state the facts. The effect of all this is that almost every operation—even a very small one—has to be planned and government is inevitably involved, if not in the actual mining, then in the supply of some essential requirement.

Having regard to her small population, Australia is making a noteworthy contribution to the United Nations' need for mineral supplies. Mining is a hazardous business at any time and it is inevitable that in the hasty planning which has been demanded some mistakes will have occurred and money spent for little return. Critical attention is apt to be focused on such expenditure, and the favourable side of the story overlooked. An immense amount of information concerning our mineral resources has been gathered during the war which will be of permanent value; a stimulus has been given to some kinds of production which should develop into a permanent feature of Australian industry; in some directions we have a definite picture where before we had merely hazy notions; and some noteworthy discoveries have been made, outstanding among which is the size and value of the King Island scheelite deposit.

ABSTRACTS AND NOTES

Columbite-tantalite in British Guiana.—A statement on the discovery of columbite-tantalite in the Mazaruni District was issued to the Georgetown Press last August by the Director of the British Guiana Geological Survey, Mr. Smith Bracewell. The mineral was first discovered about 20 years ago in the Rumong-Rumong area by Mr. Maurice Nascimento when working for diamonds. He submitted for analysis a sample of the heavy black minerals (known to the diggers as "cantangera") which occur in the diamond concentrates, with the result that the presence of tantalum was revealed. Mr. Nascimento recently offered to disclose the locality to Government, and in January 1944 he conducted Mr. Bracewell to the place on a left bank tributary of the Rumong-Rumong River where he had obtained his original samples. Representative samples were taken, and a preliminary analysis of these indicated the presence in one sample of a high percentage of the combined oxides of tantalum and columbium.

With the object of preventing speculative claim locations, the basin of the Rumong-Rumong River was closed to further prospecting and mining, except by special permission of the Governor. Mr. Nascimento has been granted six reward claims in the area. Subsequently a reconnaissance geological and prospecting survey was carried out over a belt roughly 30 miles long and 10 miles wide on the left bank of the Mazaruni between the Sipari River and the Tiboku Falls, including the basin of the Rumong-Rumong River.

It was found that columbite-tantalite with a specific gravity between 5·2 and 5·7 (and presumed to contain about 25 per cent. Ta_2O_5 and 50 per cent. Cb_2O_5) occurred within an area about 3 miles long and half a mile wide. In addition there was a more extensive area about 25 miles long and half a mile wide within which there are frequent occurrences of another columbium mineral, as yet not identified with certainty. The latter has a specific gravity of 4·7 and contains titanium as well as columbium and tantalum, and samples have been sent to the United States with a view to obtaining information as to its market value.

These occurrences are in alluvial and eluvial deposits resting upon, and derived from, a series of gneissose granites, aplites and pegmatites which outcrop in a narrow belt forming roughly a quarter circle of about 10 miles radius around Soronieng Peak. The belt lies both close to and within a prominent ridge about 700 to 1000 ft. high which is easily recognizable from the air and which is formed by the outcrop of a gabbro sill. There appears to be a close association and relationship between the gabbro and pegmatite. Somewhat similar geological conditions are known to occur in a number of other parts of the Colony, for instance, the Morabisi-Turesi-Puruni area, the Isseneru area, the Kurupung area and in parts of the Kuribrong, Potaro and Konawaruk Rivers, and a careful search for columbite in these areas is warranted.

The question as to whether the deposits in the Rumong-Rumong River area can be worked economically cannot as yet be decided, firstly because the market value of the minerals and their precise chemical composition are not yet known, and, secondly, because it has not been possible as yet to make any evaluation of the reserves within this area or to determine the cost of working the deposits. In the best deposits so far located tests have indicated that by using hand methods, i.e. a riddle, diamond sieve and battel, a production of about 1 lb. of coarse concentrate per man per day was obtainable from 1000 lbs. of gravel. In addition, columbite-tantalite occurs in the country rocks of this area, and a field test of one exposure indicated the presence of about 1 lb. of the mineral in 1 ton of rock. These figures compare favourably with recoveries reported to be obtained from Brazilian occurrences, but in the latter the percentage of tantalum in the mineral and its market value is probably much higher.

In the alluvial and eluvial deposits the mineral was found to occur in coarse grain from $\frac{1}{8}$ in. to 1 in. in diameter and it was found that the most effective method of recovery by hand methods was to pass the gravel first through a $\frac{1}{4}$ in. or $\frac{1}{2}$ in. riddle on to a 14-mesh diamond sieve. The gravel caught by the riddle was examined before being discarded. The diamond sieve was then jigged and "made up" as in diamond jigging, which results in the coarse concentrate being brought to the centre of the sieve. This concentrate was then cleaned in the battel. This method was found to be more efficient than that in which the gravel is first puddled in a gold "Tom" and the concentrate collected on a short sluice with riffles and expanded metal.

The most favourable localities for finding the mineral appear to be in small ravines draining areas of pegmatite. Owing to the prevalent rains, it was not possible to carry out any adequate prospecting of the flats of the main Rumong-Rumong River and its tributaries. It is probable that columbite-tantalite occurs in the alluvial deposits of these rivers, and it was proposed to prospect these by drilling and pitting later in the year.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

PORCELAIN AND OTHER CERAMIC INSULATING MATERIALS. By Dr. Ing. Ernst Rosenthal. Volume One. Raw Materials, Manufacturing Processes, Testing and Characteristics. Pp. xii + 278, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1944.) Price 28*s*.

This book is stated in the author's preface to be written primarily for engineers and manufacturers who use, or contemplate using,

porcelain and similar ceramic materials in their products or in their electrical or chemical plants.

The principal chapters deal with the characteristics of porcelain and other ceramic materials, raw materials, testing of raw materials, manufacture, and ceramic high-frequency materials. There are brief chapters on insulators for spark plugs, influence of glazes on the technical characteristics of porcelain, plaster of Paris, and high frequency ceramic condensers and coils.

It is doubtful whether the user, who is probably more concerned with the performance of the finished product than with details of its manufacture, will appreciate much of the detailed information given in the chapters on raw materials, their testing and manufacturing processes. The text of the book comprises 280 pages, and these three sections occupy more than half of them. The book, therefore, seems more likely to appeal to the ceramist, who will find in it much information which is not readily accessible elsewhere in one volume.

The section on manufacture, which is the longest in the book, is of much interest, though the treatment of certain aspects, e.g. grinding, is perhaps rather brief.

The book, as a whole, fills a need for a concise summary of information on porcelain, and any criticisms are mainly on points of detail. The chief of these is the paucity of references to contemporary literature, and it is to be regretted that the short bibliography at the end of Chapter 3 has not been followed by similar lists throughout the rest of the book.

The assertion on page 118, that "rational analysis makes use of the fact that when clay substance is placed in boiling concentrated sulphuric acid for 20 hours it is attacked and completely decomposed and transformed into water soluble salts," takes no account of the behaviour of the combined silica in the clay, and the procedure in any case cannot be recommended as a laboratory method. On page 85 the main characteristic of bentonite is said to be its very great plasticity, but no mention is made of its remarkable swelling properties, and on page 93 India is not mentioned as the chief world producer of kyanite, the U.S.A. only being recorded.

Apart from such blemishes, the book, which is well illustrated, can be recommended to those wishing to gain an insight into the properties of porcelain and modern methods of its manufacture.

W. O. R. W.

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EMPIRE EDUCATIONAL FACILITIES

EXHIBITION GALLERIES, LANTERN SLIDES, FILMS, LECTURES, Etc.

NOTES

Exhibition Galleries.—On the principle that the Youth of to-day is the Empire Builder of to-morrow, the Empire Courts of the Exhibition Galleries have been specially planned to meet the educational needs of the rising generation. In actual fact, school-children, both in school classes and in family parties, constitute the predominant class of visitor received, and therefore any hindrance to their coming and going has a very marked effect on the total number of visitors. This applies with particular force to the half-year now under review, a period which coincides approximately with the period during which the major attacks of flying bombs have been sustained against "Southern England, including the London area." As is now common knowledge, the start of these attacks on June 13 led to an immediate large-scale evacuation of schoolchildren from London and the surrounding districts, which in normal times are the Galleries' main "feeders," and to the cancellation of extra-mural school visits of those children who remained. These two factors caused an equally immediate drop of fully 85 per cent. in our attendances. Even with this greatly reduced attendance the Galleries carried on for a further fortnight, but with the persistence of the attacks, coupled with the official warning of the dangers of flying glass, it soon became obvious that the Galleries, with their large windows, numerous roof lights and hundreds of showcases, were not a proper place in which the public should be encouraged to congregate, and so, on July 3, for the second time during this war, their doors were reluctantly closed until further notice.

However, as was the case during the previous period of closure, the Collections have been kept intact, the slight damages caused by a few "near misses" have been made good, and the Empire Courts are still available for inspection by organised parties or by duly authorised individual visitors, the former by arrangement with the General Secretary and the latter by personal application at the Inquiry Office. During the past half-year the number of parties which have taken advantage of these facilities was 52, and the total number of visitors 6963.

Among the organised parties, most of which have been conducted

round the Galleries by the Institute's guide-lecturers, were several composed of Indian and South African troops, formerly prisoners-of-war in enemy hands, and it has been particularly interesting to note their enthusiastic reactions on reaching the Courts of their respective home countries.

Additional to all these visitors are the Colonial Service officers, who during their periods of leave in this country have called to inspect the Courts in which they are interested. A list of them appears on pages 320-1.

Among distinguished visitors who have been received by the Director and have made tours of the Galleries or visited a particular Court are :

July 8 : Mr. R. B. Pugh, Public Relations Officer, Dominions Office.

July 14 : Mr. C. W. Scott, O.B.E., D.F.C., I.F.S., Conservator of Forests, Burma.

July 28 : Mr. P. L. Mainwaring Evans, Education Officer, International Wool Secretariat.

August 3 : Dr. K. A. Korsah, O.B.E.,
Dr. E. H. Taylor Cummings, M.B.E.,
The Rev. Rasome Kuti,
Members of the Rt. Hon. Walter Elliot's Committee on Higher Education in West Africa.

August 24 : Mr. A. J. Wakefield, C.M.G., Inspector General of Agriculture, British West Indies.

August 29 : Prof. Daryll Forde, Ph.D., Director, International African Institute,
Mr. R. Kirkwood, Member of the Legislative Council of Jamaica.

September 5 : Mr. W. A. B. Iliffe, Financial Adviser to H.E. The Governor of Burma.

September 14 : Sir Arthur Bruce, K.B.E., Burma Office.

September 21 : Mr. K. L. Little, University Museum of Archæology and Ethnology, Cambridge.

September 29 : Mr. C. G. Denham, C.I.E., C.B.E., Managing Director, Anglo-Dutch Plantations of Java.

October 2 : Mr. Malcolm Guthrie, Lecturer in Bantu, School of Oriental and African Studies.

October 3 : Field Marshal Sir Claud Jacob, G.C.B., G.C.S.I., C.M.G., former Commander in Chief, India.

October 5 : Dr. Théodore Monod, Directeur de l'Institut Français d'Afrique Noire, Dakar.

October 13 : Mr. Walter Hett, Representative of the British Council in Cyprus.

October 19 : Lt.-Col. A. V. Agius, M.C., Trade Commissioner for Malta.

October 20 : Dr. Marushitch, acting Prime Minister, Yugoslavia ;
Dr. Cankar, ex-Minister for Education, Yugoslavia.

October 30: Sir Lancelot Graham, K.C.S.I., K.C.I.E., Governor of Sind, 1936-1941.
November 6: Sir Edmund Teale, D.Sc., M.Inst.M.M., Mining Consultant to the Tanganyika Government, 1935-1940.
November 24: Sir Charles Woolley, K.C.M.G., O.B.E., M.C., Governor and Commander in Chief, Cyprus.
November 29: Sir Shanti Bhatnagar, O.B.E., F.R.S., D.Sc., F.N.I., F.Inst.P., F.R.I.C., Director of Scientific and Industrial Research, India.
December 1: Dr. Nazir Ahmad, O.B.E., Ph.D., F.Inst.P., Director, Cotton Technological Laboratory, Bombay.
The Rt. Rev. G. A. West, M.A., M.M., Bishop of Rangoon.

New Exhibits.—The following paragraphs relate to the more outstanding additions to the Exhibition Galleries made during the past half-year.

Picture-Making in Northern Nigeria. The peoples of Northern Nigeria comprise, for the most part, communities of farmers and herdsmen whose main preoccupation in life is the ever-present struggle for existence and whose only relaxation from it are occassional celebrations and entertainments when groups of intimate neighbours foregather. They have little time, opportunity or inclination to practise any of the finer arts, and one would scarcely expect to find in them any spontaneous urge for artistic self-expression; still less, the necessary ability to give it tangible form. Yet quite the reverse of this has been proved by an interesting experiment carried out by Mr. W. F. Jeffries, a Nigerian Education Officer, some of the results of which are now on exhibition in the West African Court. They take the form of a set of water colour pictures made by young Nigerians selected from local schools for training at the Bauchi Training Centre for Elementary Teachers, and they show such remarkable clarity of conception, design and execution that the manner in which they came into being is of especial interest. On their arrival at Bauchi, where Mr. Jeffries was the Officer in charge, the students had completed their normal schooling without art instruction of any kind; most of them had never even tried to draw. But the sight of Mr. Jeffries, himself an artist of ability, at work at his spare-time hobby aroused among some of them a desire to try and paint pictures, and it was this urge coming from such artistically raw material which prompted Mr. Jeffries to institute his experiment. Accordingly, he bought a supply of cheap school colour-boxes and other materials, showed the students how they should be used, and then left them more or less to their own devices. As the experiment was a side-line to the normal curriculum of teacher-training laid down for the Centre little time could be spared for formal instruction and such help as Mr. Jeffries gave was limited to a minimum of technical advice. As he himself says, " With no precedent to follow, it was impossible

to aim at any particular standard and so lay down a course of exercises by which that standard could be attained. Much, therefore, of what was first attempted proved abortive, but it was soon established that not only had great interest in the possibilities of picture-making been aroused, but that there was also an astonishingly high degree of latent natural ability hitherto undisturbed."

Curiously enough, the students did not use their newly-discovered faculty in recording the scenery around Bauchi, but instead they employed it as a means of conveying their mental impressions of the various incidents which formed the background of their respective home and village lives. They represented many different races and had come from localities of widely different characters, but all shared the common culture spread by Islam. Each therefore had something to tell of the different ways in which the same thing was done in different places, and they found in drawing a ready means of discussing these differences. The pictures, therefore, are memory drawings made with a deep desire to tell a convincing tale; the fact that several of them are quite works of art is fortuitous. Only an inspection of the originals will convey their charm, but some impression of the pictures can be gained by the eight reproductions in black and white shown in Plates II-IX.[1] together with the following comments on them supplied by Mr. Jeffries and reprinted from *Oversea Education*:

> "Prayer." The viewpoint of experience and not of objective observation. As a participant the artist is aware of the bowing backs of his fellow worshippers, each clad according to personal taste, but all subordinated to the discipline of the ritual.
>
> "Tailor's Shop." An open stall in a city market, where imported prints rapidly become "stock" garments on the sewing-machine. The picture is bright with the sophistication of modern youth, contemptuous of the drab drudgery of homespun, and alert to exploit the superficial brilliance of the mass-produced.
>
> "Mother and Child." This student found in drawing the means to express, with sincerity, the simple background of every-day life. He relied less than any of the others on the trappings of the special occasion for inspiration.
>
> "Koran School." The traditional method of Moslem education is depicted here. Instruction is "individual" as each pupil makes what speed he can to learn to write and repeat by heart the passages of the Koran prescribed. The atmosphere of confusion in which the experienced teacher pursues his course with easy assurance and a stick is well caught in the grouping of the picture.
>
> "A Singing Game." Hausa girls go to market in their best clothes, and show them off when they gather round the drummer for a singing game. No skilful dancing is seen, but the monotonous rhythm of the drum, the song, the clapping of hands and the

[1] Printed from blocks kindly supplied by H.M. Stationery Office, publishers of *Oversea Education*.

shuffling steps, produce a holiday mood of pleasurable excitement. The picture shows that the male spectator is more interested in the appearance of the girls than in their actions.

"Hunting Party." This picture is noteworthy not only for the accuracy with which facts have been observed, but also for the psychological content of its emotional atmosphere. The young men are obviously excited by anticipation, while the dogs are content to follow in docile servility until stimulated by actual sight or scent.

"Pounding Corn." Rhythm is the thing. Heavy work is lightened by the music of the pestle handled with a supple skill that is athletic in its co-ordination of balance and timing.

"Stick Fight." The various forms of single combat, at one time practised in real earnest by hardy nomadic peoples, survive as colourful entertainment to be seen in rural markets during the slack period after harvest. The violence of the figures in action is emphasised by the background of passive spectators.

The present collection of pictures does not, however, constitute the end of the matter, for the students have also been encouraged to use the whitewashed walls of their classrooms for the reproduction of picture maps and illustrative diagrams which will help to focus teaching in many subjects, their particular advantage over printed maps or wall charts being that they can be adapted to the special requirements of a particular locality. Some of the abler and more energetic students have in this way carried out quite extensive schemes of mural decoration.

The whole experiment proves not only that Northern Nigerians can draw and like drawing, but also that the time is ripe for the introduction of the teaching of art into the schools as a definite subject. How the knowledge of this fact should influence the framing of a future educational policy is a matter for consideration.

New Arms for Malta.

"To honour her brave people I award the George Cross to the Island Fortress of Malta to bear witness to a heroism and devotion which will long be famous in history." In April 1942, in these words, King George conferred upon Malta an honour which has now received further perpetuation in the new Armorial Bearings granted to the Colony by Royal Warrant, dated December 28, 1943, which reads "Per pale Argent and Gules on a Canton Azure a representation of the George Cross proper."

The Colony's new Arms have been prepared in the form of a large wall shield and a silk banner and added to the Malta Court, where they provide a striking note of colour. The former is the work of Mr. Herbert H. Cawood, A.R.B.S., and the latter that of the Royal School of Needlework. For purpose of comparison, a small shield bearing the Colony's former Arms is shown on an adjacent wall.

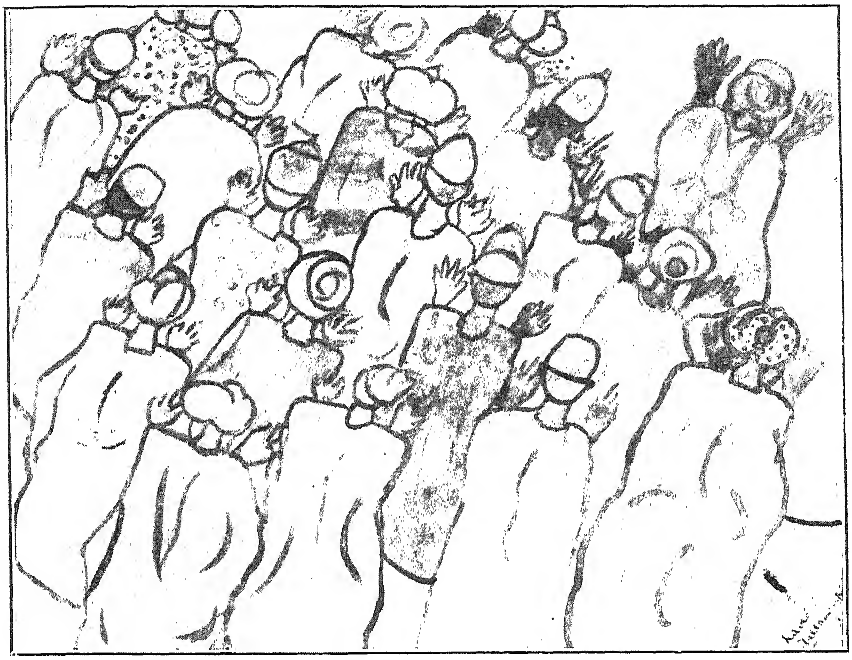


PLATE II. PRAYER.

PLATE III. TAILOR'S SHOP.

PLATE IV.

MOTHER AND CHILD.

PLATE V.

KORAN SCHOOL.

PLATE VI. A SINGING GAME.

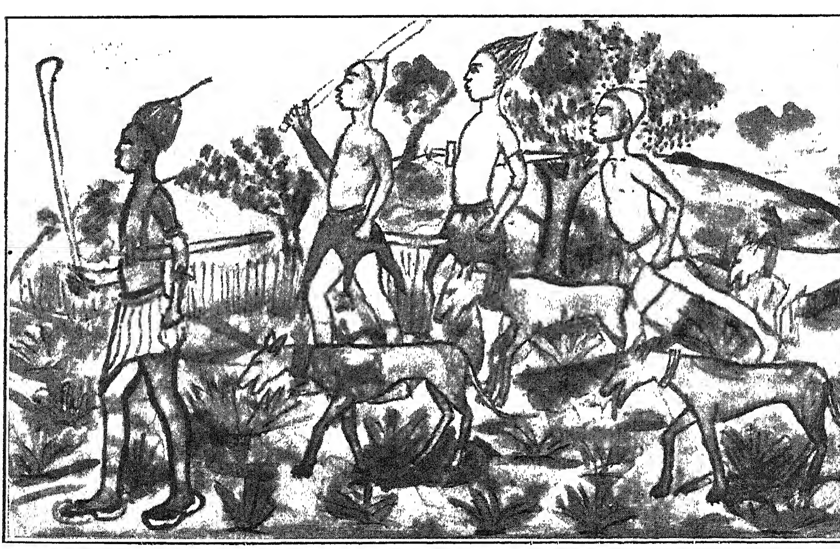
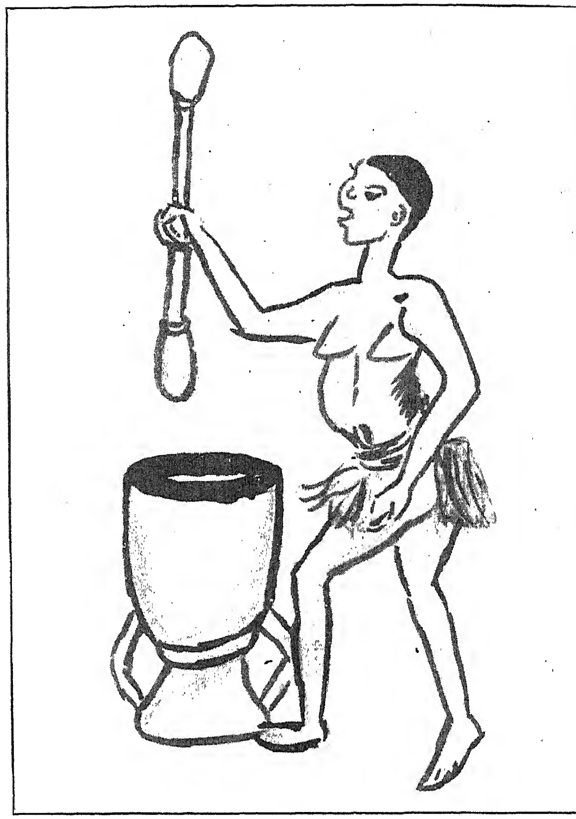


PLATE VII. HUNTING PARTY.

PLATE VIII.



POUNDING CORN.

PLATE IX.

STICK FIGHT.

Empire Lantern Slide Library.—During the six months April to September 1944 covered by this report 22,380 lantern slides have been issued to schools and lecturers in the United Kingdom. The details are shown below.

	April.	May.	June.	July.	Aug.	Sept.
United Kingdom	180	60	120	240	120	240
Australia	480	420	480	60	—	240
Canada	600	720	120	240	120	720
New Zealand	120	120	180	60	—	—
South Africa	60	—	240	60	—	240
India	660	480	240	540	120	600
Burma	300	180	120	60	60	540
The Colonial Empire	1,320	1,740	2,460	1,620	480	1,260
Products of the Colonial Empire	120	180	180	240	180	60
General Tours	180	360	300	60	120	240
History	60	420	480	180	—	—
	4,080	4,680	4,920	3,360	1,200	4,140

A new Picture Talk on "Australia of To-day" has been written by the Australian News and Information Bureau, London. After a brief reference to the size and position of the continent of Australia, the method of government and the place reserved for aborigines in the community, the talk develops on the theme of industrial and agricultural progress during the last few years. This is followed by illustrations of the concern of Australian Governments for the social wellbeing of young people—the crèches, schools, universities, and the opportunities for outdoor sports such as cricket, swimming and ski-ing, ending with pictures of the unusual species of animals indigenous to Australia.

Mr. Humphrey Bowman, C.M.G., C.B.E., has written a Picture Talk on "Modern Palestine." Beginning with the physical features of the country, Mr. Bowman shows the outstanding agricultural and industrial development which has taken place since 1920 as a result of the Mandate. Jews and Arabs are shown working in their orange-groves, vineyards, and agricultural experimental schools. Bedouin in their tents and their camels in the Judaean Desert are followed by pictures of the shrines of the Christian, Islam and Jewish faiths which give the country its claim to be the Holy Land.

Sir John Cumming, K.C.I.E., C.S.I., has written a talk on "India's Old-Time Buildings." The talk is divided into sections dealing with prehistoric remains, inscribed pillars, Buddhist stupas, Jain memorials, rock excavations, Hindu temple architecture and Mohammedan buildings.

Central Film Library.—The loan of films from the Library is now being maintained at a rate of 8,000 to 9,000 films a month. The figures are rather lower in the summer months and higher in the peak months, November to March. Limitations of staff and space are likely to restrict any further increase on these figures.

But the number of films available from the Library continues to increase as new films are received from the Dominions and India and are produced by the Ministry of Information. Among those received recently are the following from India: "From Silkworm to Parachute," "Soil Erosion," "Hillmen go to War" (a picture of village life in the Kulu Valley), three films on Indian dances, one on Indian musical instruments and one on the handicrafts of Travancore. Among new films about Canada are "Trans-Canada Express," "Gaspé Cod Fishermen," "Hands for the Harvest," "People's Bank" (the story of the Farm Credit Unions of Canada) and "Farm Front." The first films in a series on the West African colonies being produced by the Ministry of Information in collaboration with the Colonial Office should be available from the Library early in 1945.

Empire Lectures to Schools.—During the second half of the lecture season which ended on August 31, 1944, 937 lectures were delivered to audiences aggregating 142,576 school children as against 823 lectures to audiences aggregating 125,812 children during the corresponding period last year.

Details of the lectures given during the lecture year ended August 31, 1944, in comparison with the previous year are as follows:

Subject.	1942-3.	1943-4.
Canada	116	121
Australia	198	422
New Zealand	58	135
South Africa	88	142
India	162	275
British Colonies	690	829
General Empire	164	253
Total	1,476	2,177

Audiences.	1942-3.	1943-4.
Northern Counties	66,388	92,502
Western Counties	17,339	39,508
Eastern Counties	2,352	550
Midland Counties	44,323	84,017
Southern Counties	111,246	112,772
Total	241,648	329,349

On September 30, 1944, a Conference of lecturers was held at the Imperial Institute. The purpose of the Conference was to discuss the best means of telling the Empire story. Sir Harry Lindsay took the chair and gave the opening address. He drew attention to a specially drawn map of the British Commonwealth (which was coloured in such a way as to show the political individuality of the various parts of the Empire), and he invited the lecturers

to use the following preface when lecturing to schools as an introduction to the "New Imperialism."

"*Preface which may be used with any Empire Lecture.*

The talk which you are to hear to-day is on the subject of , which is a member of the British Commonwealth.

The British Commonwealth of Nations is the largest aggregate of free peoples ever known. It extends over about one-quarter of the world's surface and contains one-quarter of the world's population. Its citizens are of every race, religion, custom and colour. At the apex of the whole system stand the self-governing Dominions of Canada, Australia, New Zealand, South Africa and Eire, each of them as free and independent as Britain itself. The rest of this world-wide society is moving steadily towards the same goal—freedom within the Commonwealth. Some members, such as India, Ceylon, or Southern Rhodesia, stand already on the verge of complete self-government. Others, Colonies, often with a large measure of self-government already, or Protectorates, mostly in Africa, are being administered deliberately with a view to attaining to the same ultimate goal. Unlike any other previous empire, the British Empire has never attempted any uniformity of pattern. It is in fact a world-wide democracy, no member of which shows any desire to link its fortune with any form of totalitarian government. Its growth in the main has been due neither to political design nor to conquest, but to the natural expansion of an enterprising island people, to very powerful humanitarian and religious movements, and, above all, to the individual enterprise of British traders and settlers, quite unassisted by their governments. Throughout its modern history the Commonwealth has attempted to preserve the two great principles on which the British way of life is founded—tolerance and justice. No man is persecuted for his opinions, no man is above the Law. For backward races the British Commonwealth regards itself as a trustee—a trustee on behalf of the peoples themselves, until they reach maturity, and a trustee on behalf of the rest of civilization. It is not too much to claim that this is the greatest political achievement in history. From the summer of 1940 to the summer of 1941 it stood alone in defence of the future of men. Such is the great community of whose manifold activities we are to consider one aspect to-day."

Copies of the Preface, together with coloured slides of the map, were distributed to the lecturers present. A stimulating discussion followed, and it was agreed to hold a second Conference in January 1945.

Empire Schools Correspondence.—During the six months under review the Empire Schools Correspondence Scheme, which was inaugurated at the beginning of 1944, has made notable progress.

Directors of Education in the following Colonies have sent names of children anxious to write to boys and girls in the United Kingdom: Barbados, British Guiana, British Honduras, Ceylon, Cyprus, Falkland Islands, Fiji, the Gambia, Gold Coast, Grenada, Kenya, Malta, Mauritius, Nigeria, Northern Rhodesia, Sierra Leone, Tanganyika and Trinidad. Since the Scheme commenced no less than 2,462 names of children overseas have been received. Although many of the lists have only recently been received 1,452 have already been "paired" with pupils in widely scattered schools, in town and country, throughout the United Kingdom. In a letter, the Superintendent of Education, Falkland Islands, wrote: "the children here, living in a small and isolated community, are very eager for any contacts with the outside world such as your Scheme offers." The Colonial Secretary, Grenada, in a letter enclosing lists of names of children, said: "I desire to convey to your Institute on behalf of the youth of this Colony, an expression of their appreciation of the opportunity afforded them, through this medium of personal contact, of making contributions to the work of promoting a spirit of closer relationship within the Empire." The response from Head Teachers in this country has been equally encouraging. The Institute is indebted to the Educational Institute of Scotland for kindly undertaking to operate the scheme in Scotland.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the period June-November 1944:

JUNE

R. AVICE, Sugar Technologist, Department of Agriculture, Mauritius.
C. K. BROOKE-HUNT, Education Officer, Nigeria.
J. R. MILLER, Agricultural Officer, Nigeria.
J. W. R. PEDDER, Senior Agricultural Officer, Nigeria.
A. PITCAIRN, Assistant Director of Agriculture, Cyprus.
V. B. V. POWELL, Education Officer, Nigeria.
J. M. S. USHER-WILSON, Agricultural Officer, Nigeria.

JULY

J. GOEPEL, M.A., late Political Officer in Aden Protectorate (seconded to Colonial Office).
O. D. PATERSON, Inspector of Mines, Nigeria.
J. W. PURSEGLOVE, Agricultural Officer, Uganda.
C. L. RICE, Education Officer, Nigeria.

AUGUST

R. BRACEGIRDLE, Manager, Enugu Colliery, Nigeria.
DR. R. M. EAST, Senior Education Officer, Nigeria.
DR. J. E. HARDY, Chief Plant Protection Officer, Palestine.
G. PROCTER, Ceramist, Gold Coast.
A. P. A. ROBERTSON, Inspector of Mines, Nigeria.
C. SWABEY, Conservator of Forests, Jamaica.
W. H. THORP, Senior Education Officer, Nigeria.
A. J. WAKEFIELD, C.M.G., Inspector-General of Agriculture, West Indies.

SEPTEMBER

H. E. Box, Entomologist, Gold Coast.
J. S. Dunn, Government Chemist, Gold Coast.
T. J. Lennard, Administrative Officer, Gold Coast.
H. E. Lironi, Cinema Officer, Information Department, Gold Coast.
Dr. F. J. Martin, C.B.E., M.B., F.R.I.C., Director of Agriculture, Sierra Leone.
Captain L. Nicholls, M.C., Chief Conservator of Forests, Nigeria.
Miss G. Plummer, Education Officer, Nigeria.
R. O. Roberts, M.Sc., Geologist, Uganda.
B. J. Silk, Agricultural Officer, Gold Coast.
F. W. Toovey, Botanist, Agricultural Department, Nigeria.
B. E. Webb, Utilization Officer, Forests Department, Tanganyika Territory.
C. E. J. Whitting, Senior Education Officer, Nigeria.

OCTOBER

E. W. Box, Plantation Assistant, British Cameroons.
James Dundas, Senior Assistant Conservator of Forests, Nigeria.
G. N. Herington, Agricultural Education Officer, Nigeria.
F. H. Landon, Assistant Conservator of Forests, Gold Coast.
Capt. P. F. Masterton-Smith, M.C., Senior District Officer, Nigeria.
E. S. Packham, Assistant District Commissioner, Gold Coast.
W. M. Rogers, Tobacco Officer, Ceylon.
John Seamer, Sudan Civil Service.
Dr. J. D. Tothill, C.M.G., Principal, Gordon Memorial College, Khartoum.

NOVEMBER

S. Antebi, B.Sc. (Edin.), Agricultural Officer, Palestine.
J. H. Chalk, Inspector of Mines, Nigeria.
C. Graham, Education Officer, Nigeria.
W. Victor Harris, Entomologist, Tanganyika.
W. E. Holt, Education Officer, Nigeria.
E. B. Hosking, O.B.E., late Chief Native Commissioner, Kenya.
W. B. Mason, Agricultural Superintendent, Gold Coast.
J. C. Muir, O.B.E., Director of Agriculture, Zanzibar.
D. F. Sargent, Superintendent, Agricultural Department, Kenya.
G. H. Vivian, Inspector of Mines, Nigeria.
R. R. Waterer, Conservator of Forests, Cyprus.
Mrs. Welton-Ward, Mistress, Bishop's High School, British Guiana.
C. Whybrow, Superintendent of Education, Tanganyika Territory.
Sir Charles Woolley, K.C.M.G., O.B.E., M.C., Governor and Commander-in-Chief, Cyprus.

All Dominion, Indian and Colonial Officers, as well as private residents of the Overseas Empire, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss with the Director and his staff, scientific and technical problems in which they may be interested.

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Scientific names and titles of books are printed in italics and personal names in capitals